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Roentgenologic Study of the Small Intestine[1]

II. Dysfunction Associated with Neurologic Diseases

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THE GASTRO-INTESTINAL tract is richly supplied with nervous tissue, both intrinsic and extrinsic. The former consists of plexuses beneath the mucosa and between the muscular layers; the latter consists of sympathetic and parasympathetic connections with the central nervous system. Golden and others (2, 5) have suggested that the grossly disturbed function and altered roentgen appearance of the intestine in severe nutritional disorders such as sprue may be due to degeneration of the nerves supplying the gut. Important as the autonomic nerves undoubtedly are in controlling the motor and secretory functions of the gastro-intestinal tract, the clinical manifestations of neurogenic intestinal dysfunction in less exotic diseases certainly are not well established. This may be due to the fact that organic diseases restricted to the autonomic neurons are rare, and that the presenting abnormalities ordinarily relate to disturbed orthostatic blood pressure regulation, defective sweating or thermal regulation, bladder paralysis, etc.

We have approached the problem of investigating the possible role of the autonomic nerves in causing disturbed motor function of the intestinal tract by carrying out roentgen studies in selected patients with well defined neurologic disease. Several categories of patients were used (Table I). Since our previous clinical studies (9) have shown that autonomic nerve disease occurs to an unusual extent in patients with diabetic neuropathy and gives rise to strikingly unusual gastro-intestinal symptoms, this group was of particular interest. Intestinal and bladder disturbances are common in the neurologic disease occurring as a manifestation of pernicious anemia, in tabes dorsalis, etc. Other opportunities for investigation occurred in patients in whom the vagus nerves were sectioned in the treatment of intractable peptic ulcer or incidentally during total or subtotal gastric resection. The effect of splanchnicectomy and lower thoracic ganglionectomy was studied in patients in whom this operation was carried out for the treatment of arterial hyper-

TABLE I: NEUROLOGIC DIAGNOSES IN PATIENTS SELECTED FOR ROENTGEN STUDY OF THE INTESTINAL TRACT

Diabetic neuropathy	35 cases
Pernicious anemia	20 cases
Tabes dorsalis	5 cases
Miscellaneous neurologic diseases:	
Peripheral neuropathy, etiology unknown	4 cases
Guillain-Barré syndrome	1 case
Peripheral neuropathy with lead poisoning	1 case
Autonomic nerve paralysis	1 case
Sympathectomy	8 cases

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TABLE II: CLINICAL FINDINGS IN 30 PATIENTS WITH DIABETIC NEUROPATHY AND GASTRO-INTESTINAL SYMPTOMS

Impotence, atonic bladder (either or both)	18 cases
Diabetic retinopathy	16 cases
Orthostatic hypotension (drop of 50 mm. Hg or more in systolic blood pressure)	8 cases
Hepatomegaly	6 cases
Gastro-intestinal symptoms:	
Cramps, pain, borborygmi	22 cases
Anorexia	20 cases
Severe constipation	15 cases
Vomiting	13 cases
Fecal incontinence	8 cases
Diarrhea	7 cases
Alternating diarrhea and constipation	4 cases
Nocturnal diarrhea	3 cases

tension. An example of autonomic nerve paralysis occurring spontaneously as a disease entity was also included in the study. It was hoped that investigation of material of this type might contribute to our basic knowledge of neurogenic intestinal dysfunction.

DIABETIC NEUROPATHY

At the outset of the disease individuals afflicted with diabetes mellitus have but one defect, a deficiency of insulin. Under optimal conditions this deficiency can be corrected and health maintained indefinitely. All too frequently, however, imperfect regulation over the course of years permits the development of complications, among which is to be found a characteristic degenerative disease affecting the peripheral nerves. The neurologic disorder resulting from diabetes is a chronic, and often severe, neuropathy with an unusual predilection for the autonomic nerves. This is evidenced by sweating deficiencies, impaired mechanisms of heat regulation, defective orthostatic blood pressure control, neurogenic bladder paralysis, etc. Only when meticulous diabetic regulation is maintained over a period of many months do the neurologic state and the attendant symptoms improve.

Gastro-intestinal abnormalities are not found with unusual frequency among patients with uncomplicated diabetes, or even with diabetes which is temporarily out of control. When diabetic neuropathy develops, the majority of patients complain of serious and unusual gastro-intestinal disturbances. In a recent study involving a large group of such patients, these abnormalities developed with the neuropathy in over 60 per cent of the cases (9). Symptoms referable to the lower intestinal tract were predominant and usually appeared first. In two-thirds of the cases there was severe and nearly intractable constipation. In the remaining third a chronic diarrhea developed, sometimes alternating with severe constipation and sometimes occurring as a distressing nocturnal diarrhea, often with fecal incontinence (11). In those with severe or progressive neuritic disease, symptoms of upper intestinal tract dysfunction were common, including postprandial distention, cramps, profound anorexia, and nausea and vomiting after meals.

Prolonged delay in gastric emptying and disorderly transit of intestinal contents along the intestinal tract were discovered in five of the cases of diabetic neuropathy previously reported (9). Thirty additional diabetics with neuropathy and associated gastro-intestinal symptoms have since been investigated. The diabetic background and neurologic status in this group were comparable to those previously reported. The incidence of associated complications, retinopathy, hepatomegaly, orthostatic hypotension, genito-urinary abnormalities, and gastro-intestinal symptoms is tabulated (Table II). On the basis of appropriate diagnostic procedures, the presence of diseases other than diabetic neuropathy was excluded.

CASE 13 (Fig. 9 A-1, 2, 3):[3] G. W., a 29-year-old white farmer, came to the hospital complaining of a painless deformity of the left ankle of two months' duration. He had had diabetes since the age of twelve years, but it had always been treated erratically. Five years after the onset, severe diabetic acidosis occurred, with the development of a large subcutaneous infection. For five years the patient's general health had been such that he was able to work only about half time. For at least two years his lower legs and feet, as well as his forearms and hands, had

[3] Case numbers and figure numbers in this paper follow consecutively those in Part I of this study (Radiology 49: 587, November 1947).

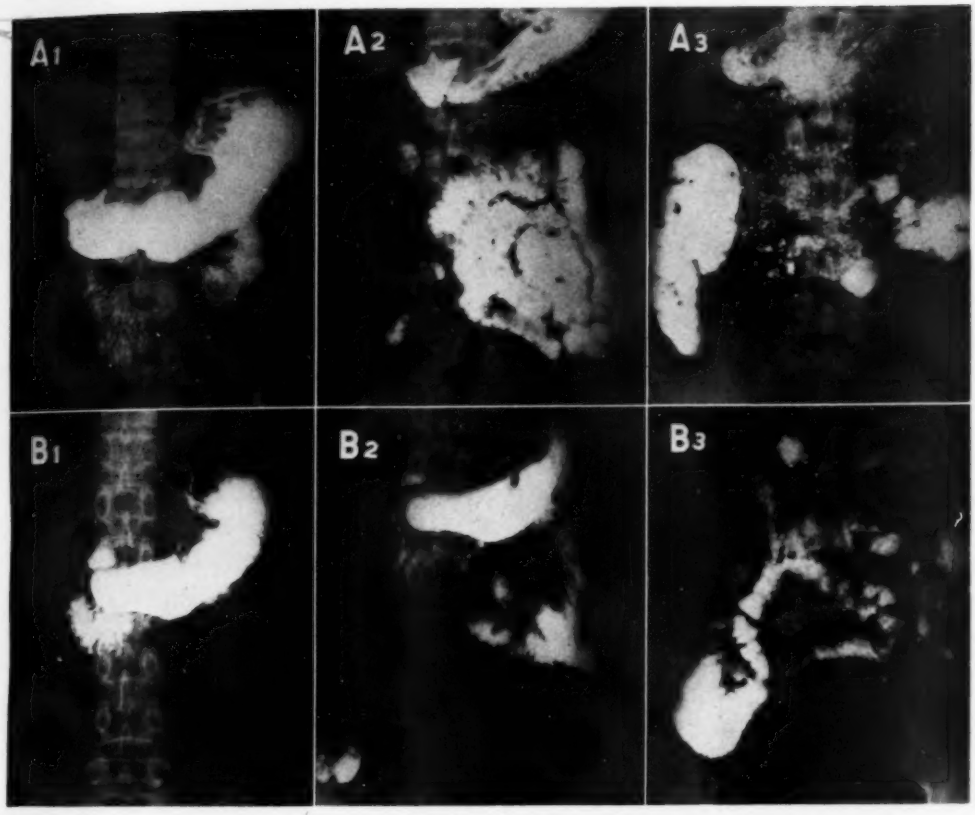

Fig. 9. Functional small bowel disturbance.

A-1, 2, 3. Case 13. In this case of poorly controlled diabetes with definite signs of neuropathy, exposures immediately, two and a half, and five hours after feeding show delayed gastric emptying, prolonged small bowel transit time, considerable variability of small bowel lumen width, and displacement of small bowel loops by the distended bladder.

B-1, 2, 3. Case 14. Another example of small bowel dysfunction encountered in a patient with diabetes and associated evidences of neuropathy. Exposures immediately and at two and a half and five hours again show recognizable signs of dysfunction.

felt numb. His calf muscles were tender to pressure and became sore after exercise. He had noticed the absence of sweating distally in the extremities. For four or five years he had spells of diarrhea with six to eight stools per twenty-four hours, most of them occurring at night. Two months before hospitalization his left ankle began to swell, lose its normal shape, wobble, and crunch as he walked.

On physical examination, the patient appeared to be well developed but weak. There were numerous punctate hemorrhages in both optic fundi. The knee and ankle reflexes were absent. Deep and cutaneous senses were severely impaired below the knees and over the hands. There was no sweat secretion or pilomotor function in the lower legs. The left ankle was a shapeless joint, the weight being borne on the head of the fibula. The joint was entirely painless to manipulation. Serologic tests for syphilis were negative. The spinal fluid was normal except for protein content of 160 mg. per 100 c.c. Cystometric examination showed atonic bladder paralysis. Roentgen examination of the left ankle joint showed extensive disruption and subluxation of the joint relationships.

CASE 14 (Fig. 9 B-1, 2, 3): N. L. L., a 48-year-old married white woman, had had unregulated diabetes for fourteen years, with one bout of diabetic acidosis and a continuous and heavy glycosuria. Neuritic symptoms had occurred in the extremities early in the illness. For seven to eight years she had suffered from chronic diarrhea occurring especially at night and during the early evening. The larger meals were usually

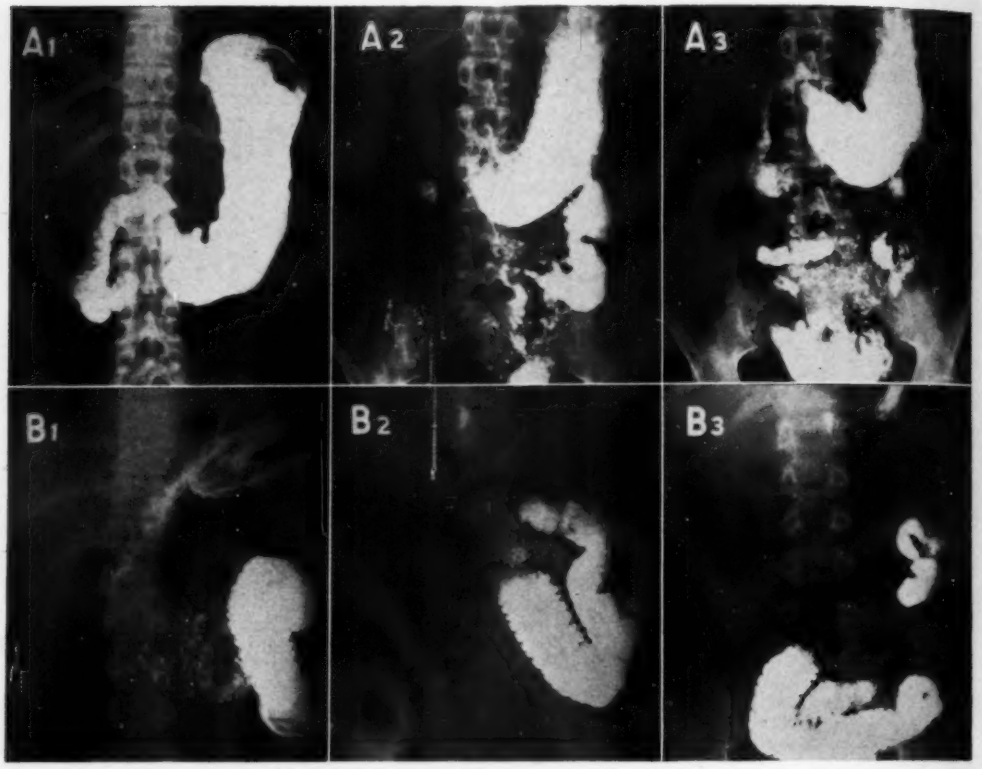

Fig. 10. Functional small bowel disturbance.

A-1, 2, 3. Case 15. Exposures immediately and at intervals of two and a half and five hours after feeding in a patient with diabetes associated with peripheral neuropathy. In this instance delayed gastric emptying and delayed small bowel motility are strikingly shown. Note also the very considerable variability of lumen width and the virtual absence of mucosal markings in several bowel loops.

B-1, 2, 3. Case 16. Comparable exposures immediately and at two and a half and five hours in another patient with associated diabetes and peripheral neuropathy. Note here the widened lumen of small bowel and the greatly delayed transit time, as well as considerable amounts of gas within otherwise unfilled loops of small bowel.

followed by cramps, gas, abdominal distention, and urgent bowel movements. Five months before examination, anorexia, frequent vomiting, and fecal incontinence developed.

At the time of physical examination, the patient was obviously chronically ill. The blood pressure in the supine position was 205/100 and on standing 155/80. Bilateral cataracts and diabetic retinopathy were present. Neurologic examination showed severe blunting of the cutaneous senses distally in the extremities. Cystometric examination showed atonic bladder paralysis.

CASE 15 (Fig. 10 A-1, 2, 3): J. Q., an 18-year-old white girl, had had diabetes since the age of fourteen. She was not at all co-operative in following any recommended treatment and was in diabetic acidosis several times. Severe diabetic neuropathy finally developed a few weeks after an episode of diabetic coma. When admitted to the hospital for the treatment of this complication, the patient complained of a complete lack of appetite, nausea with vomiting whenever she ate more than small quantities of food, and periodic diarrhea alternating with severe constipation.

CASE 16 (Fig. 10 B-1, 2, 3): M. W. R., a 17-year-old white boy, had had diabetes since the age of five. His treatment had been erratic and he failed to grow and develop normally. At the age of twelve he developed a convulsive disorder which interfered further with diabetic management. At the time of physical examination he was found to be poorly developed and dwarfed. His liver was definitely enlarged. The tendon reflexes were sluggish or absent.

The patient was admitted to the hospital for diabetic regulation. Four weeks after this was

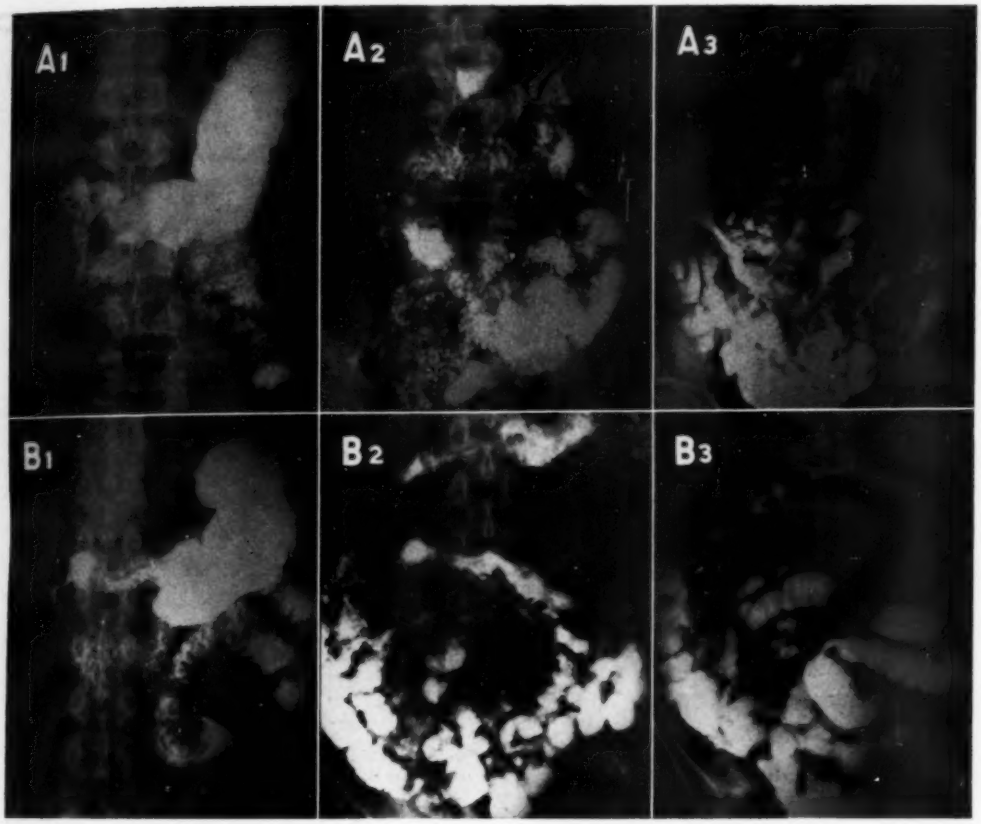

Fig. 11. Functional small bowel disturbance.

A-1, 2, 3. Case 17. Films made immediately and at two and a half and five hours in another example of diabetes with peripheral neuropathy. Delayed transit time is the major feature in this instance.

B-1, 2, 3. Case 18. Another example of clear-cut roentgenologic evidence of small bowel dysfunction in a patient with diabetes and peripheral neuropathy. Although barium has reached the transverse colon at the five-hour interval, much of the opaque meal has been left in broad and narrow small bowel segments.

started, burning pains in the lower legs, severe cutaneous hypersensitivity with desquamation, and finally shallow ulcerations about the toes developed. At the time of the neuritic exacerbation a profound anorexia occurred, with a feeling of gastric fullness lasting several hours after eating. Gastro-intestinal x-ray examination was performed on two different occasions when symptoms were acute. After four months of satisfactory diabetic regulation there was definite improvement in the neurologic symptoms. Examination showed little evidence of residual neurologic disease. All symptoms referable to the gastro-intestinal tract had disappeared.

CASE 17 (Fig. 11 A-1, 2, 3): C. E., a 43-year-old white truck driver, had had poorly treated diabetes for eight years. Heavy glycosuria, loss of weight, chronic fatigue, impotence, and moderately severe neuritic symptoms developed eight months before hospital admission. The symptoms became much worse during a severe upper respiratory infection several weeks later, and at that time the patient's weight fell from 142 to 118 pounds, his appetite vanished, and severe constipation developed. Examination in the hospital showed weak, tender muscles in his legs and diminished to absent reflexes. At the time of the gastro-intestinal examination he complained of poor appetite and severe constipation.

CASE 18 (Fig. 11 B-1, 2, 3): J. F. was a 57-year-old white salesman. Six months before his admission to the hospital he experienced fatigue, lethargy, and severe pain in the legs. A heavy glycosuria was discovered, but no treatment was instituted. In spite of a large food intake during

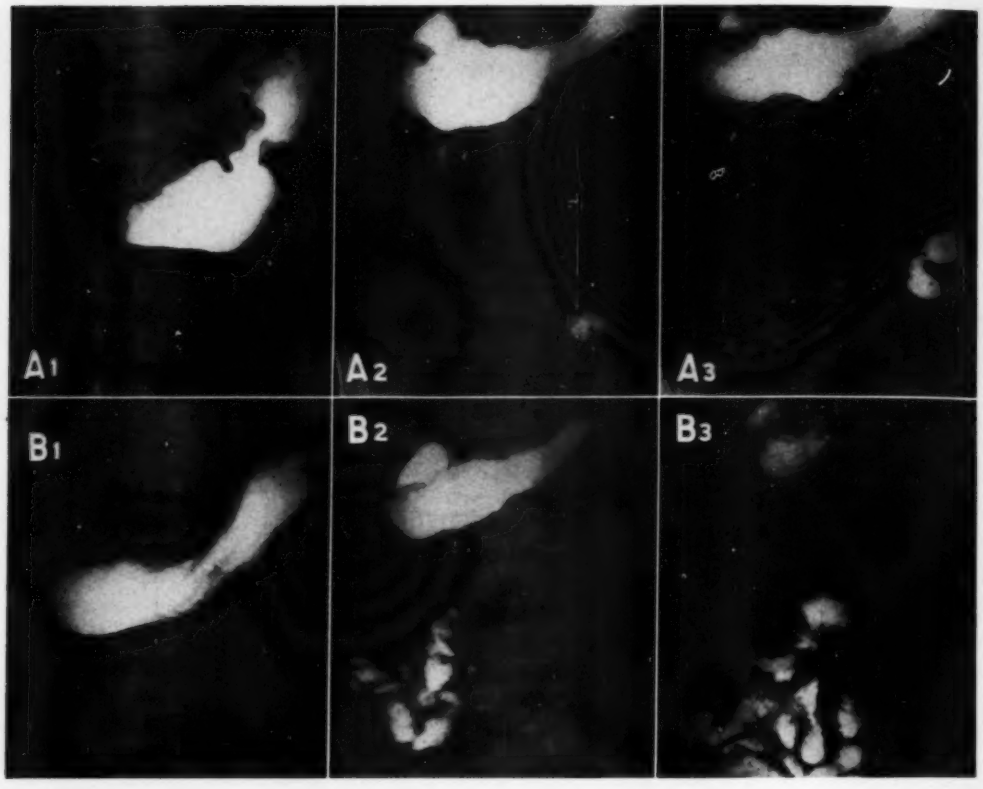

Fig. 12. Functional small bowel disturbance.
A-1, 2, 3. Case 19. Profoundly delayed gastric emptying as shown in exposures immediately and at two and a half and five hours after feeding in a diabetic with peripheral neuropathy.
B-1, 2, 3. Evidence of improved function in same patient following treatment of diabetes.

the next few months, his weight fell from the usual 203 pounds to 144 pounds. The pain and weakness in his legs increased until he could not walk. Severe constipation developed, and finally anorexia, with nausea after eating. Physical examination disclosed evidence of moderately severe peripheral neuropathy with partial foot drop on the left. During the week preceding the gastro-intestinal examination heavy oral and parenteral vitamin B therapy was administered. This form of treatment had no observable effect on the patient's neurologic status, and the gastro-intestinal symptoms remained unaltered.

After ten months of careful diabetic regulation the patient had improved generally and was able to walk six or eight blocks without difficulty. The gastro-intestinal symptoms had disappeared. Evidence of neurologic disease remained.

CASE 19 (Fig. 12 A-1, 2, 3; B-1, 2, 3): E. H., a 34-year-old white farmer, had diabetes at the age of 20. Following the initial regulation, he abandoned the recommended dietetic regimen and two years later there was an episode of coma. Six years after this he had severe diabetic acidosis and a small lung abscess, which required ten months' treatment in the hospital. His subsequent regulation was aimed only at keeping his urine free of ketone bodies. For six years he had had chronic diarrhea with six to nine stools per day, most of them following meals or at night, when they were accompanied by fecal incontinence.

On entrance to the hospital the patient was fairly well developed and nourished. Blood pressure in the supine position was 200/100 (pulse 114), and on standing 118/80 (pulse 150). Diabetic retinopathy was present. The liver was enlarged. The tendon reflexes were absent and there was severe blunting of the cutaneous senses about the lower extremities. Cystometric examination showed an atonic bladder paralysis.

Roentgenographic findings in these cases

covered a wide range of abnormality falling under the heading of "disordered motor function" as described by Golden. Some degree of gastric retention, prolonged barium transit through the intestinal tract, and segmentation of the barium column were fairly constant features. The caliber of the gut lumen showed considerable variation, and localized segments of dilated gut were encountered. The mucosal pattern was well preserved in most cases. However, localized coarsening, irregularity, and partial obliteration of folds were not infrequently observed. Scattered gas accumulations in the small bowel were likewise noted in a number of instances.

In many of the patients with diabetic neuropathy, roentgen evidence of disturbed gastro-intestinal function was less conspicuous than the clinical symptomatology would lead one to expect. The deviation from normal, however, was greater among those with severe neuropathy and in those with the more pronounced intestinal symptoms. The type of roentgen abnormality present, with the exception of prolonged gastric retention, gave little clue to the nature of the presenting clinical symptoms in most cases. Abnormalities of the same type and degree occurred in those suffering from severe constipation as in those with chronic diarrhea. Gastric retention and delayed transit through the bowel were found, for instance, in many of those who complained of diarrhea. There were no features by which patients with nocturnal diarrhea could be separated from those with daytime diarrhea. Two patients were re-examined after prolonged treatment had resulted in definite neurologic improvement. In spite of the virtual absence of gastro-intestinal symptoms, the roentgen findings showed that return to normal had been incomplete.

PERNICIOUS ANEMIA

An assortment of gastro-intestinal disturbances has long been included among the classic symptoms of pernicious anemia. With the advantages of modern diagnostic methods and the availability of curative therapy, these symptoms may now be more precisely analyzed and a group associated with neurologic dysfunction recognized. Mild chronic complaints such as indigestion, limited tolerance for certain foods, post-prandial bloating, the frequent passage of soft stools, etc., are common in uncomplicated cases during complete spontaneous or therapeutic remissions. Profound anorexia with distaste and aversion to food often occurs early in the development of pernicious anemia or during a relapse of the disease before anemia and other clinical manifestations become severe. Renewed appetite and ability to eat follow in two to four days after the beginning of effective treatment. Again, patients who become merely anemic usually suffer from anorexia with vomiting when the hemoglobin level drops below about 5 gm. per 100 c.c. Alleviation of the symptoms depends upon raising the hemoglobin level by blood transfusion or by effective anti-anemic therapy. None of these symptoms appears to be closely related to the recurrent pain and soreness of the tongue associated with visible lingual abnormalities—lack of coat, atrophy of lingual papillae and, when the anemia is not severe, a scarlet or beefy red color.

A still different train of symptoms is encountered in patients with pernicious anemia who show the more severe degrees of neurologic disorder, especially when this has resulted in neurogenic bladder paralysis, sometimes with the loss of sphincter control (10). Severe constipation, requiring continual catharsis or frequent use of enemas, is the earliest and most persistent symptom. Later abdominal distention, cramps, and borborygmi tend to follow each meal, and in long-untreated cases diarrhea with fecal incontinence develops. These symptoms begin to subside only after several weeks of specific therapy, and improvement parallels restoration of peripheral nerve function.

Among the 20 patients with pernicious anemia in relapse who were available for special small bowel examinations, 10 were simply anemic. Roentgen evidence of

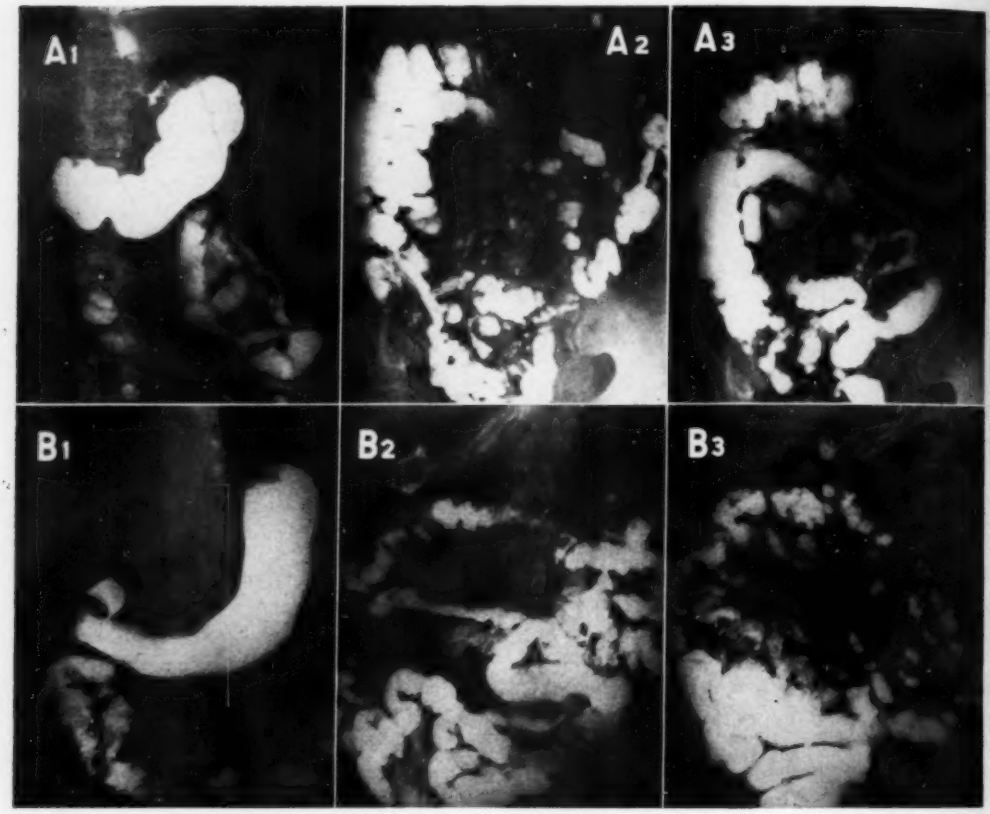

Fig. 13. Functional small bowel disturbance.

A-1, 2, 3. Case 20. Delayed small bowel transit, segmentation of barium column, and variability of lumen width observed immediately and at two and a half and five hours after feeding in a patient with proved pernicious anemia and associated peripheral neuropathy.

B-1, 2, 3. Case 21. Similar though more profound evidences of small bowel dysfunction in another patient with pernicious anemia and peripheral neuropathy. Exposures made immediately and at two and a half and five hours after barium feeding.

disturbed intestinal function was unimpressive in this group, and they became symptom free one to four weeks after specific therapy was begun. Five individuals had pronounced atrophy of the lingual mucosa with neither severe anemia nor neurologic disease. Again no definite evidence of intestinal dysfunction was observed. Conspicuous abnormalities were, however, discovered in those patients with severe neurologic disease. Significant gastric retention was not observed; otherwise signs of disturbed intestinal function were not unlike those encountered in diabetics with associated neuropathy. Three illustrative cases are presented.

CASE 20 (Fig. 13 A-1, 2, 3): For four to five years, N. R., a 47-year-old white woman, had had a yellowish complexion and poor appetite, with occasional nausea and vomiting. A year previously numbness and tingling in her legs developed. Three months before admission to the hospital she became too weak to walk and could no longer control her legs. Looseness of the bowels with fecal incontinence alternated with severe constipation requiring enemas. Shortly before admission urinary retention occurred.

On examination, the patient was found to be mentally confused. She was obese and her skin was lemon-yellow in color. Flaccid paralysis of the lower extremities was observed. Knee and ankle reflexes were absent and the plantar responses were upward. Vibratory, motion, and position senses were impaired to the level of the

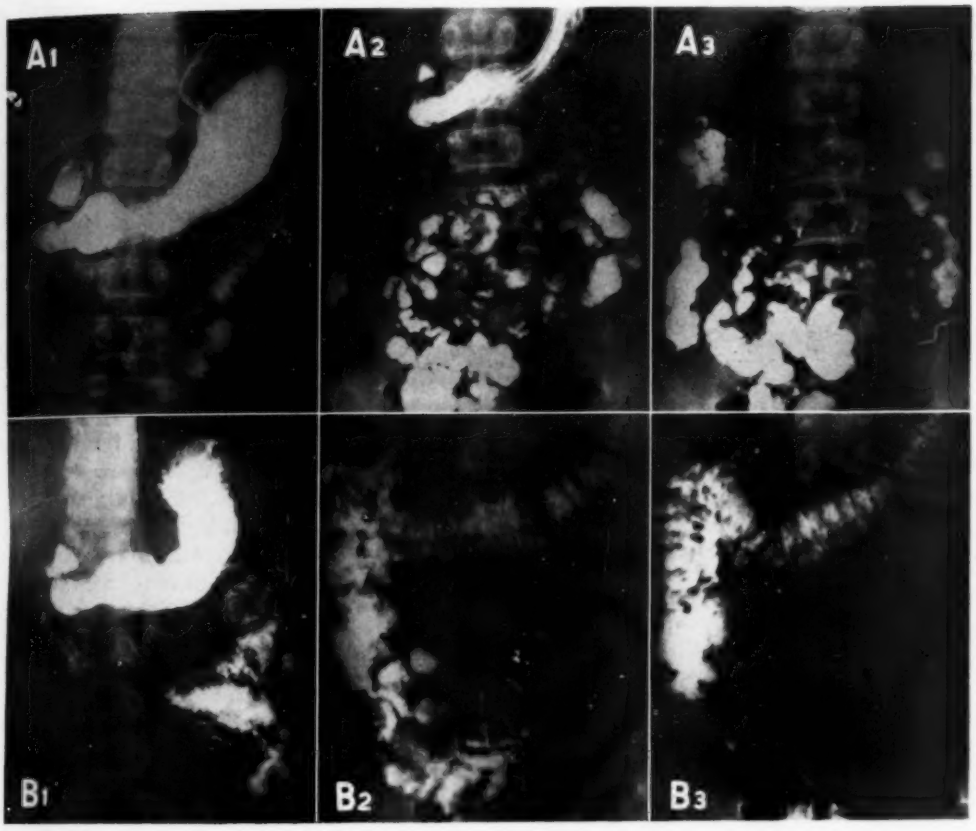

Fig. 14. Functional small bowel disturbance.

Case 22. The profound and characteristic roentgen signs of small bowel dysfunction shown in films made at once and at two and a half and five hours after feeding (A-1, 2, 3) have disappeared (B-1, 2, 3) in comparable exposures made one year later, after the symptoms and signs of pernicious anemia with associated peripheral neuropathy have responded to treatment.

pelvis, and cutaneous senses were severely blunted below the knees. Gastric achlorhydria followed histamine injection. There was a severe anemia, with the red blood count reduced to 1,000,000, the white blood count to 2,050, and the hemoglobin to 4.9 gm. per 100 c.c. The average cell volume was 115 cu. microns. Cystometric examination showed an atonic bladder paralysis with an occasional uninhibited contraction.

The patient was treated in the hospital for two months with liver extract injections, with the expected hematologic response. She became more alert and co-operative, and the gastro-intestinal complaints, with the exception of persistent constipation and occasional incontinence, disappeared. At the time of discharge she had regained some of her ability to move her legs in bed. After nine months of continued treatment, she was able to walk about, holding to a chair for support. Slight tingling persisted in her hands and feet. The tendon reflexes in the lower extremities were hyperactive and pyramidal tract signs persisted bilaterally, but there were no sphincter disturbances.

CASE 21 (Fig. 13 B-1, 2, 3): A. D., a 63-year-old housewife, had been treated for pernicious anemia four years before her hospital admission. Regular injections of liver extract had resulted in great improvement for several months, but then treatment was discontinued. For two years the patient had noticed a progressively increasing weakness of the legs, and for one year she could walk only by using a cane. Three months before admission her lower extremities became paralyzed, urinary retention and bowel incontinence developed. Her appetite became extremely poor and there were abdominal distention and occasional vomiting.

On initial examination the patient was found

to be confused and apathetic. The appearance of her tongue was normal. There was a flaccid paralysis of the lower extremities. The knee and ankle reflexes were absent, the plantar responses doubtful. There was severe blunting of the cutaneous senses below the knees. A macrocytic anemia was present, with reduction of hemoglobin to 8 gm. per 100 c.c. A cystometric examination showed an atonic bladder paralysis.

After six weeks of treatment with liver extract, the blood values were approaching normal. The appetite was fairly good and the patient was eating well. There was slight abdominal pain associated with gaseous distention and recurrent fecal incontinence.

CASE 22 (Fig. 14 A-1, 2, 3; B-1, 2, 3): A summary of the findings in this case has been reported previously (10). F. B., a 44-year-old male, had been well until one year before admission to the hospital, when numbness and tingling appeared in his fingers. Six or eight months before admission paresthesia developed in his lower extremities, finally ascending as high as his waist. At times his tongue was sore and noticeably red. He suffered from severe constipation and lost his appetite. Two months before admission to the hospital he began to stagger when walking and for two to three weeks had been unable to walk without support.

On physical examination the patient was found to be well developed and nourished, but was unable to walk without assistance. The vibratory, motion, and position senses and the cutaneous senses were blunted peripherally over the extremities, and extensor plantar responses were present. There was complete atrophy of the lingual papillae. Anemia with reduction in the hemoglobin to 7.9 gm. per 100 c.c. was present. There was gastric achlorhydria following histamine injection.

After the institution of liver extract therapy, the patient rapidly became better and all manifestations of the disease subsided. Five months after the initial examination he was back at work full time. One year after treatment was started, he had no significant neurologic complaints or residual evidence of disease. The gastro-intestinal complaints had subsided.

TABES DORSALIS

Not infrequently gastro-intestinal disturbances are a major complication where syphilitic infection of the nervous system has led to tabes dorsalis. The dorsal root ganglia of the cerebrospinal nerves are generally regarded as the chief site of neurologic involvement. While bladder paralyses in tabes have been extensively investigated, the intestinal abnormalities have received less attention. Five of our patients with tabes dorsalis due to syphilis were of special interest from the roentgenologic standpoint. Three of them were subject to "gastric crises"—acute episodes of upper abdominal pain with nausea and vomiting, lasting from two to ten days before subsiding abruptly. Only one had definite evidence of intestinal dysfunction, as indicated by prolonged barium transit time. Examinations during a period of persistent nausea and vomiting and during a symptom-free period showed no essential differences. Another patient had persistent constipation alternating with loose stools. A fifth patient was incapacitated by abdominal distention following meals, noisy intestinal peristalsis, diarrhea, urinary and fecal incontinence. Roentgen evidence of intestinal disturbance was unimpressive in these cases.

MISCELLANEOUS NEUROLOGIC DISEASES

Roentgen evidence of intestinal dysfunction was inconstantly found in patients suffering from the common types of peripheral nerve disease. Definite alteration in gut caliber and transit time, however, were observed in one patient with the Guillain-Barré syndrome complicated by bladder paralysis and in another patient with severe lead poisoning. Roentgen abnormalities observed in these cases seemed to parallel the degree of coincident autonomic nerve disease. A unique opportunity to examine the gastro-intestinal tract when a naturally occurring disease had resulted in generalized autonomic nerve paralysis was presented by the following case.

CASE 23 (Fig. 15 A, B, C.): A. F., a 42-year-old farmer, had always enjoyed good general health. Two months before the onset of his acute illness he had an upper respiratory infection with malaise and fever, from which he recovered slowly. In the middle of February 1944, his mouth and throat became persistently dry, and solid food began to stick in his throat. He suffered from excessive perspiration and fever. He was able to see distant objects well, but those

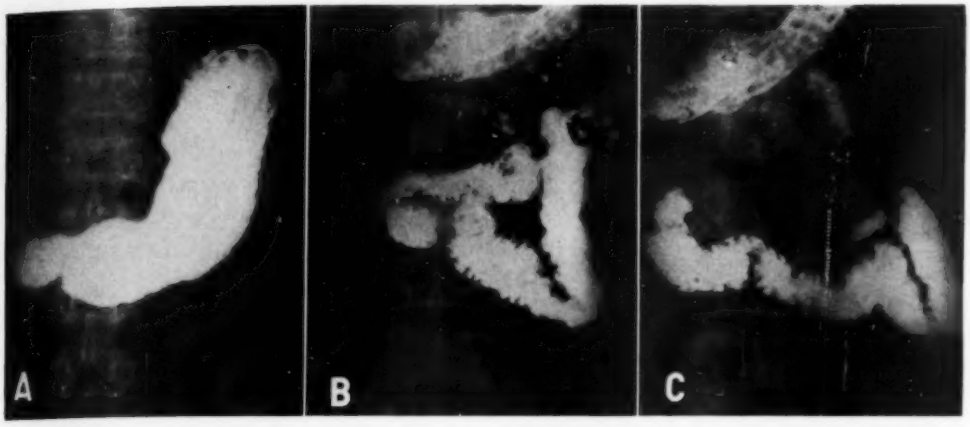

Fig. 15. Functional small bowel disturbance.
Case 23. Greatly delayed transit time after barium feeding in a patient with generalized autonomic paralysis.

close at hand were blurred unless he focused on them steadily for some moments. A few days later he began to vomit and have upper abdominal cramps following meals, spells of diarrhea, and finally rather severe constipation. Urinary hesitancy developed, with a weak stream, an uncertain sense of bladder fullness, and complete impotence. Three weeks after the beginning of his illness, the patient began to feel faint when sitting up and would lose consciousness whenever he stood erect. He became confined to bed. Two months after the onset of his illness he was admitted to the University Hospital.

On physical examination, the patient appeared well developed and well nourished. His pupils were about 4 mm. in diameter and would not react visibly to light or on accommodation. His tongue was dry. Oral secretions were scant and could not be increased by acid or salt stimulation In the supine position the blood pressure was 104/60 mm. Hg (pulse 72). When sitting up, the patient felt dizzy; his blood pressure dropped to 50/35 (pulse 68) and the radial pulse became weak and difficult to palpate. He was able to stand for only a moment before losing consciousness. Except for the fixed pupils and diminished oral secretions, no neurologic abnormalities were demonstrable.

Examination of blood, urine, and spinal fluid showed no abnormalities. Serologic tests for syphilis were negative. Cystometric examination showed atonic bladder paralysis with 300 c.c. of residual urine. The patient was painted with an iodine mixture, dusted with starch, and warmed under bakes until his oral temperature had risen 1.5° F. above normal. Slight sweating was produced about his face and neck, but elsewhere it was nearly absent.

X-ray examination on two different occasions showed a large, sluggish stomach with retained food and secretions. The caliber of the intestinal loops was somewhat increased, and transit along the tract was markedly delayed, so that at five hours the head of the barium meal had not progressed beyond the proximal jejunum.

The patient was treated symptomatically with ephedrine, amphetamine, and increased salt intake. When out of bed, he wore rubber stockings and a snug corset. After eight weeks in the hospital, he was able to be up and around much of the time. At home he improved gradually until he could resume farm work. Eleven months after the beginning of his illness his symptoms had largely disappeared and he reported that his family physician found his blood pressure well maintained when standing.

EXTRINSIC DENERVATION OF THE GUT

Abundant evidence has been presented above to show that neurologic disease affecting the autonomic nerves is productive of gastro-intestinal symptoms and convincing roentgen evidence of abnormal function. The problem next arises as to whether the responsible neurologic disease involves the extrinsic, sympathetic and parasympathetic, neurons, or the intrinsic plexuses, or both. Information bearing on this point has been gained by studying patients in whom the vagus nerves have been resected in the treatment of intractable peptic ulceration, and in patients subjected to sympathectomy in the treatment of arterial hypertension.

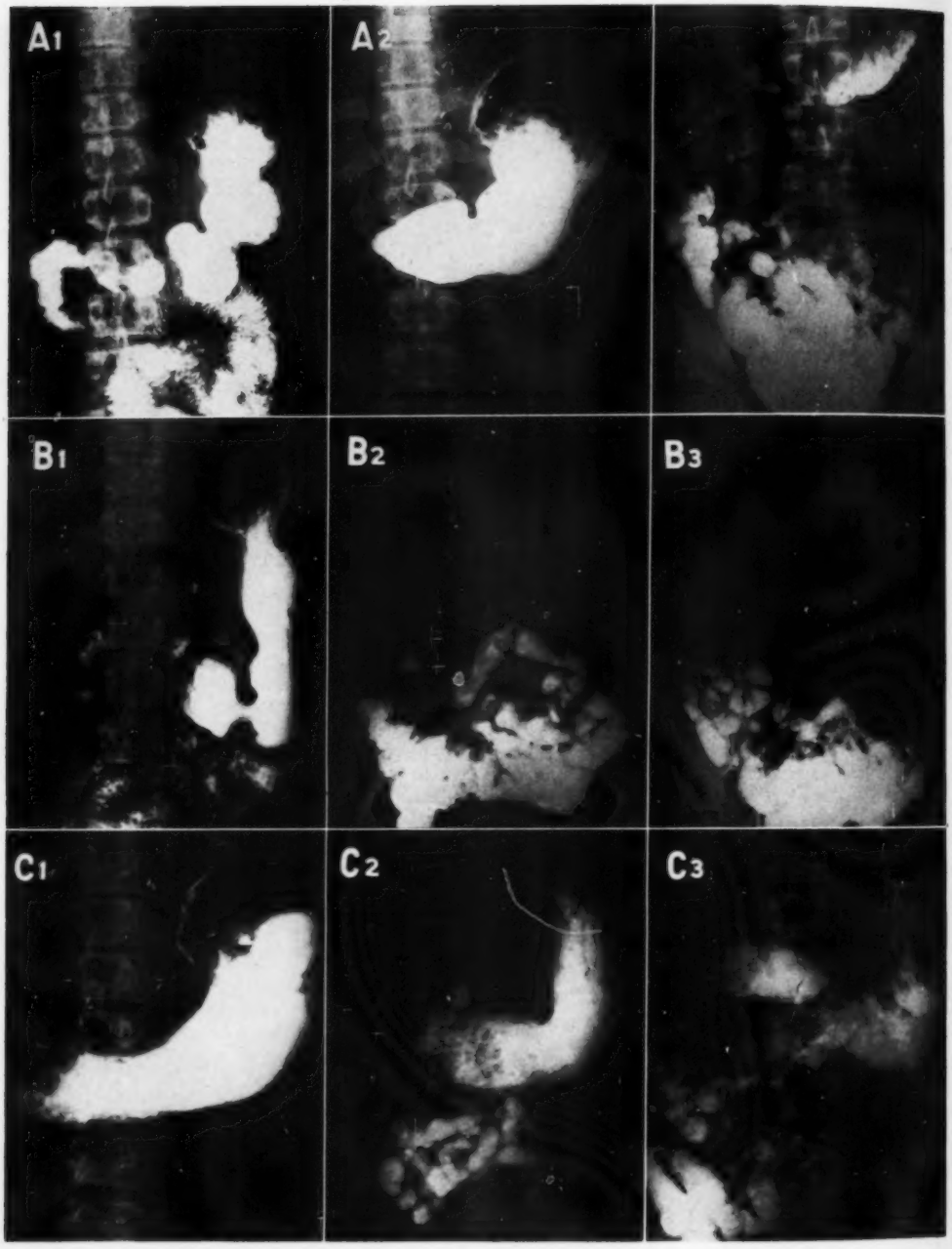

Fig. 16. Functional small bowel disturbance following surgical procedures.

A-1. Upper gastro-intestinal tract immediately after barium feeding, showing deformity of duodenal ulcer. Note multiplicity of peristaltic contractions and delicate mucosal pattern of upper small bowel.

A-2, 3. Exposures made immediately and five hours after feeding in the same case, following vagotomy for relief of ulcer symptoms. Note altered appearance of the stomach, delayed gastric emptying, delayed small bowel motility despite advance of some opaque material into the transverse colon. In this instance alteration of stomach and small bowel behavior has followed the purposeful interruption of autonomic nerve supply.

[*Legend continued on opposite page.*]

Figure 16 A-1 is a reproduction of a film made after barium feeding, showing a duodenal ulcer deformity, active gastric peristalsis, and delicate mucosal pattern of the upper small bowel. After vagotomy (Fig. 16 A-2, 3), in the same patient, the stomach is dilated, gastric emptying is delayed, and passage of the barium along the intestinal tract is slower. Distention of the stomach together with prolonged retention and sluggish peristalsis were found to be characteristic features following vagotomy in a large patient group. In association with the above findings, slight increase in jejunal caliber, coarsening of mucosal pattern, and delayed transit time were commonly encountered (3).

An expected postoperative complication following resection of the splanchnic nerves and lower thoracic sympathetic ganglia is a train of symptoms referable to the upper gastro-intestinal tract. For some weeks after the operation most patients have a complete absence of hunger and a profoundly diminished appetite for food. Nausea and vomiting may follow overfeeding. Intestinal cramps and pain, easily distinguished from the radicular pain following resection or traumatization of intercostal nerves, are often severe. Abdominal distention, tenderness to deep palpation, and increased peristaltic activity are commonly present. The disturbances subside in a few weeks and do not reappear.

Roentgen examination of the bowel was performed before and after operation in eight patients in whom it was necessary to treat arterial hypertension by bilateral supradiaphragmatic splanchnicectomy and lower dorsal sympathetic ganglionectomy. Before the operation, these patients had had no significant gastro-intestinal symptoms. After the operation, however, symptoms as described above occurred. Postoperative x-ray examinations were made ten days to four weeks after operation, when the patients had been out of bed and walking to the bathroom as they pleased for several days. Figure 16 B-1, 2, 3 shows the normal appearance of the stomach and small bowel in a patient with hypertension. Figure 16 C-1, 2, 3 shows comparable exposures in the same patient obtained two weeks following operation. In this instance, the alteration in appearance and behavior of the stomach and small bowel is striking. The majority showed nothing more than delayed transit time following the operation. In other patients, in whom more extensive sympathectomies were done, with removal of the entire sympathetic chains from the first thoracic to the second lumbar ganglia, in two stages, no more dramatic changes were observed. Subsequent examinations as late as three months after operation showed very little or no deviation from the normal except slight slowing of transit time (1).

DISCUSSION

Despite the increasing literature in recent years concerning small intestine disorders, accurate clinical recognition of such disturbances in day-by-day practice is still uncommon. Unless severe nutritional deficiencies or actual intestinal obstruction develop, typical symptoms are apt to be dismissed as being "non-characteristic," "functional," or "psychogenic" in origin. Such symptoms, of course, are characteristically random, changeable complaints associated with other evidences of emotional instability, and remain perpetually benign without leading to serious physical consequences. No convincing evidence has been presented to show that emotional turmoil or psychiatric disturbances alone are capable of consistently altering the expected roentgen appearance of the intestinal tract. In the ordinary process of diagnosis, common lesions of the stomach, duodenum, and colon should be excluded at

B-1, 2, 3. Normal appearance of stomach and small bowel immediately and two and a half and five hours after feeding in a patient with hypertension.

C-1, 2, 3. Comparable exposures in the same patient obtained two months later, following bilateral supradiaphragmatic splanchnicectomy. The alteration in appearance and behavior of the stomach and small bowel as the result of splanchnic interruption is striking in this instance.

the outset, as such organic diseases may disrupt the function of the whole tract. Rare complications should not be overlooked, such as gastrocolic fistulae or any side-tracking operation, as these may produce striking nutritional disturbances and intestinal abnormalities (4). As one's familiarity with the distinctive symptoms of small bowel dysfunction increases, however, initial recognition of the situation becomes possible.

The commonest symptom indicating the need for roentgen examination of the small bowel is any gross change in bowel habit, such as intractable constipation with alternating diarrhea or chronic diarrhea in the absence of organic colonic disease. Another indication is localized or diffuse colicky abdominal pain associated with increased intestinal peristalsis, borborygmi, and gaseous distention. Occasionally small bowel dysfunction will result in greatly delayed gastric emptying in spite of free passage of barium into the upper intestinal loops. We have observed well marked intestinal dysfunction in two patients who were typical examples of the clinical syndrome "anorexia nervosa." A further indication is unexplained bleeding from the intestine, gross or occult, or recurrent anemia, which is particularly suggestive of chronic inflammatory disease or neoplasm of the small bowel.

A confirmed diagnosis of small intestine disease is practically dependent in most cases upon roentgenologic study. The limitations of standard routine procedures in this regard should be clearly appreciated, as well as the fact that many patients with genuine disturbances will not have conspicuous roentgen abnormalities even when the intestine is adequately studied. While errors in roentgenologic interpretation can easily be made in considering minor deviations as reliable evidence of disease without regard to the range and variability of the normal, consideration of all the facts bearing on the case will usually lead to a reasonable conclusion.

When convincing abnormalities of the intestine are uncovered, the findings will frequently fail to justify a positive diagnosis as to etiology. Localized abnormality of the small intestine may exhibit features which are fairly characteristic of inflammatory or neoplastic disease (3). However, it must be borne in mind that widespread evidence of intestinal dysfunction may occur in the presence of organic disease, and the local lesion itself may be entirely obscured by these changes. While this occurs more often with segmental or regional enteritis, neoplastic involvement of gut, either localized or generalized, may result in a similar appearance. A great variety of conditions may lead to intestinal dysfunction beside the above, among which are primary and secondary nutritional diseases, intestinal parasitism, hypoproteinemia, autonomic nerve disease, neuromuscular degeneration, purpura, etc. In most instances, therefore, the roentgenologist must content himself with a report of "intestinal dysfunction" and await appropriate clinical study, with specific therapy when available, and follow-up examinations to settle the diagnosis. Effective therapy is unlikely in the absence of a correct diagnosis.

The widespread use of "deficiency pattern" as an inclusive term suggesting roentgenologic evidence of disease essentially due to lack of common vitamin fractions in the diet may easily lead to serious misinterpretation. There is no confirmation of the idea that simple nutritional deficiency is the common denominator in diverse intestinal diseases. Early observers were undoubtedly correct in emphasizing the non-specific nature of the described changes (5, 6, 12, 13). It is unsafe to regard structural abnormalities in the gut as representing primary nutritional deficiencies beyond the extent to which they can be corrected in a few weeks' time by specific therapy, as can other deficiency manifestations. It has been shown experimentally that nutritional inadequacy may, however, predispose to secondary inflammatory changes (8), and evidences of the latter may persist in spite of nutritional rehabilitation. In the small number of

patients with primary dietary deficiencies studied in our series, including an instance of severe pellagra of nearly thirty years' duration, roentgen evidence of small bowel disturbance was not impressive in comparison with the other types of cases cited.

Chronic inflammation of the small intestines certainly occurs oftener than is positively diagnosed. Little is known of the natural history of the non-stenosing types of ileitis and ileojejunitis. The recent production of a chronic inflammation simulating regional ileitis by the injection of homologous serum is of extreme interest (7). Although disturbed nutrition is commonly observed in inflammatory diseases of the intestine, the structural and motor abnormalities frequently persist to a lesser or greater extent after their correction. No specific therapy is as yet effective in eliminating the infection, and surgical removal of the diseased segments of the gut is often eventually necessary.

Evidence has been presented that autonomic nerve disease occurring as an isolated disorder, or as one aspect of a more extensive neuropathy, may produce grave disturbances in gastro-intestinal function. Most naturally occurring neuropathies probably affect both the extrinsic and intrinsic neurons. The relative importance of each is difficult to estimate in individual cases. The extrinsic sympathetic innervation of the gut appears to be of minor importance in controlling motor function, since in most cases little alteration follows operative resection. Surgical removal of the parasympathetic innervation of the upper gastro-intestinal tract by vagus nerve resection results, however, in marked alteration in both motor and secretory function (1). The tendency toward more frequent, softer stools, or even severe chronic diarrhea, which follows vagotomy in a considerable percentage of cases is noteworthy. The parasympathetic autonomic nerves appear to be of generally greater importance in influencing intestinal function than the sympathetic. Preliminary observations indicate, also, that in the treatment of neurogenic intestinal disturbances the long-acting parasympathetico-mimetic drugs are of definite promise.

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Spanish summary on following page

SUMARIO

Estudio Roentgenológico del Intestino Delgado.

II. Disfunción Asociada a Neuropatías

Tratando de determinar el posible papel que corresponde a los nervios del sistema autónomo en la etiología de la disfunción motriz del tracto intestinal, efectuáronse estudios roentgenológicos en enfermos que mostraban bien definidos trastornos neurológicos, incluso neuropatía diabética, anemia perniciosa con disfunción neurológica, tabes dorsal y un caso de parálisis neuroautónoma que sobrevino espontáneamente como entidad patológica.

Obtuviéronse pruebas de que una neuropatía del parasimpático, ya se presente como trastorno aislado o como aspecto de una neuropatía más difusa, puede ocasionar graves perturbaciones de la función gastrointestinal, que pueden ser observadas clínica y radiográficamente. Los hallazgos roentgenológicos abarcaron una amplia escala de anomalías encasilladas en el encabezado general de "disfunción motriz" del tubo digestivo.

A fin de determinar el relativo papel de las neuronas extrínsecas, simpáticas y parasimpáticas y de los plexos intrínsecos en la producción de tales trastornos, ejecutáronse investigaciones roentgenológicas en enfermos en quienes se había verificado una vagotomía por úlcera péptica o fortuitamente durante una resección gástrica y en otros que habían sido objeto de una esplacnicectomía y ganglionectomía torácica baja por hipertensión arterial. La inervación simpática extrínseca pareció revestir importancia secundaria en la regulación de la función motriz del intestino, dado que en la mayor parte de los casos se observó poca alteración consecutivamente a una resección. En cambio, la extirpación cruenta de la inervación parasimpática de la porción superior del aparato gastrointestinal por medio de la vagotomía produjo marcada alteración en la función tanto motriz como secretoria.

Newer Methods of Pneumoarthrography of the Knee with an Evaluation of the Procedure in 315 Operated Cases[1]

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INTRODUCTION

THE EARLIEST recorded use of pneumoarthrography of the knee was made by Werndorff and Robinson (1) in 1904, and although numerous studies of the method have been made since that time, it has not achieved widespread popularity as a diagnostic procedure, for several reasons:

In the first place, the method requires extensive experience so that a good technic may be developed and film studies can be accurately interpreted. Most reported series of cases in this country have been small, and the accumulated experience of any one man has been limited.

In the second place, there has been some misunderstanding regarding the inherent danger of the method. Kleinberg (2) has reported the occurrence of air embolus, but in that instance adequate precautions were not taken to make certain that the needle was not in a blood vessel. Actually, this danger is inherent in any subcutaneous or intramuscular injection if such precautions are neglected. In over 800 pneumoarthrographic studies we have had not a single complication; nor were any complications encountered in Oberholzer's series of 1,200 cases (3). Hauch (4) has cited a personal communication from Samuel in which infection was mentioned as a complication. This danger is certainly minimal if proper surgical asepsis is employed. We have had no case of sepsis in our experience. If pneumoarthrography is attempted in the presence of joint effusion, the effusion may be temporarily increased. Since we have found, however, that the occurrence of fluid diminishes the efficacy of the method, we refrain from employing it in the presence of joint effusions so far as feasible.

Finally, the value of the method has not been accurately assayed in many large series of cases. There are numerous reports in the German literature, but, as pointed out above, most of the reported series from this country are small. Kleinberg (5), in 1921, reported a small series but was not overly successful at that time. He recommended the method for detection of loose bodies and hypertrophied synovial tissue, but not for detection of loose or injured semilunar cartilages. Bernstein and Arens (6) injected carbon dioxide into the knee joint and likewise showed the usefulness of the method for the diagnosis of synovitis but not for semilunar cartilage abnormalities. Rechtman (7) emphasized the value of pneumoarthrography as affording an opportunity for a definite pathologic diagnosis instead of the somewhat vague "internal derangement." Operative procedures could thus be accurately planned instead of being merely exploratory.

Bircher (8) reported 250 cases in which 3 to 5 c.c. of abrodil (20 per cent) were combined with oxygen for contrast, giving good diagnostic results. The use of lipiodol in the knee is contraindicated by the study of Burman, Tunick, and Pomeranz (9). Boyd (10) used iopax in a small number of cases, but largely for demonstration of the bursae rather than the semilunar cartilages; and quantities of less than 60 c.c. were recommended because of the possibility of irritation.

[1] Cleared for publication by the U. S. Army Bureau of Public Relations, Sept. 25, 1945. Accepted for publication in May 1947.

Forced abduction or widening of the joint space has been used by a number of investigators. Dittmar (11) used this procedure in children or adults where there was weakness of the collateral ligaments. Felsenreich (12) showed subluxation of the medial meniscus by forced abduction but considered the method rarely of value here, though useful in testing the integrity of collateral ligaments. Nordheim (13) and also Evans (14) showed that forced abduction or traction leaves a vacuum providing contrast for the shadow of the semilunar cartilage, but after a number of minutes, fluid replaces the vacuum and contrast is no longer obtained. This was found to be true for about 70 per cent of cases in Evans' series with regard to the medial meniscus, and for some 6 per cent with regard to the lateral meniscus. In the presence of fluid, Nordheim injected air into the joint space as an aid to diagnosis, being thus the first to employ a combination of forced abduction or traction and air contrast in the knee.

Simon, Hamilton, and Farrington (15) reported a series of 21 cases of traumatic knee injuries examined with the aid of air injection, from which 28 cartilages were removed. Quaintance (16) published a series of 50 operated cases and recommended pneumoarthrography as valuable.

Hamilton (17), in 1939, reported on the use of both opaque and non-opaque media in knee pneumoarthrography and concluded that the use of a positive contrast fluid is not warranted in view of its possible irritant effect. Negative contrast studies he found of definite value.

Cullen and Chance (18) were apparently the first to report pneumoarthrographic studies employing a horizontal x-ray beam in anteroposterior projections of the knee. In a series of 22 explored patients, they found definite lesions in 18. We have modified their method by placing the knee on a fulcrum so that the weight of the leg spreads the uppermost part of the joint space where the gas accumulates.

Somerville (19) recently (July 1946) supplemented a previous preliminary report (1943) with an analysis of 331 knee examinations by air arthrography. He employed a curved cassette and oblique views of the menisci. He also opened the partially flexed joint by forcible abduction or adduction and applied a firm bandage above the knee. Two hundred and thirty-seven cases came to operation. In 211 (89 per cent) the arthrogram was proved to be correct. In 16 cases among 21, prediction of a negative finding was correct, and in 195 cases out of 216 the lesion subsequently found in the knee was accurately diagnosed.

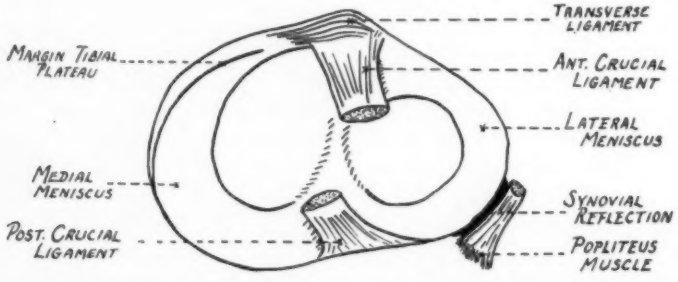


Fig. 1. Top view of tibial plateau. Note especially the synovial reflection over the popliteus muscle.

Recently, Blonek and Wolf (20) and Hauch (4) have reviewed this subject. Blonek and Wolf used 3 to 5 c.c. of 35 per cent hippuran and 150 to 200 c.c. of oxygen. Hauch used only oxygen, to the point of discomfort. Many types of internal derangement were recognized, but both series were small.

McGaw and Weckesser (21) evaluated

clinical and pneumoarthrographic errors in 101 operated cases among 207 studied by pneumoarthrography and found the method of considerable aid. Five hundred and eight pneumoarthrograms had been done by the time their paper was published, but only the first 207 of these were statistically analyzed (101 operated cases).

The present series of 315 operated cases (including the series reported by McGaw and Weckesser) from an overseas Army General Hospital is reported so that an accurate assay of the method can be made on the basis of a large material. Since an extensive experience with this method is necessary for interpretation of film findings, it has been deemed advisable to illustrate many different types of abnormalities as well as the wide limits of normal, in the hope that the procedure may be more widely and effectively employed.

ANATOMICAL CONSIDERATIONS

The *medial semilunar cartilage* (*meniscus*) is larger than the lateral, and its cornua are widely separated (Fig. 1). It is attached anteriorly to the transverse ligament, the anterior base of the anterior crucial ligament and the non-articular surface of the tibia. Posteriorly, its attachment is to the posterior intercondylar fossa of the tibia in front of the posterior crucial ligament. The circumference of the cartilage is attached to the synovial and fibrous capsules of the knee joint and the internal collateral ligament. The superior and inferior surfaces of the meniscus are not attached to any structures in the knee. The anterior cornu does not lie entirely on the rim of the tibia, as it is attached to the transverse ligament.

The *lateral semilunar cartilage* (*meniscus*) lies entirely on the rim of the lateral tibial plateau and has no peripheral capsular attachment where the popliteus muscle crosses it; here the cartilage is covered by synovial membrane. This meniscus is smaller in diameter, thicker about the periphery, and usually wider than the medial. It is attached posterior to the base of the anterior crucial ligament (unlike the medial) and anterior to the posterior crucial ligament near the intercondylar fossa.

Both menisci are covered with synovial membrane except at the rims of attachment. They are triangular in cross section. Microscopically, they contain a core of fibrous tissue arranged transversely and longitudinally, with a covering above and below of white fibrocartilage.

The *infrapatellar fat pad* is extrasynovial and is attached by a fold of synovial membrane (ligamentum mucosum) to the intercondylar portion of the femur (Fig. 4, C). The alar folds are found on either side of the ligamentum mucosum.

The *suprapatellar bursa* is lined by synovia and communicates with the joint space and with the posterior capsule. The latter consists of two globular-like bursa structures on the posterior aspect of the femoral condyles (Fig. 4, C).

The *posterior capsule* may in turn communicate with another out-pouching called either a popliteal bursa or cyst (22) (Baker's cyst) (Fig. 33).

TECHNIC

Method of Oxygen Insufflation: Oxygen is recommended for pneumoarthrography because it is quickly absorbed from the knee joint and is non-irritating. Eighty to 120 c.c. of oxygen are injected under gentle pressure into the joint space after the usual antiseptic preparation of the field and local infiltration of 2 per cent procaine down to the joint capsule. Surgical aseptic technic is employed (Fig. 2, A and B). The injection is made on the lateral aspect of the knee just below the junction of the quadriceps tendon with the superior articular margin of the patella (Fig. 2, B). The patella is displaced laterally to facilitate the insertion of the needle. As the needle passes through the capsule an initial resistance may be encountered, but if the needle is in proper position, after the first few cubic centimeters the injection proceeds easily. Usually the patient can tell the operator that the oxygen is entering the joint. The operator, on the other hand, can usually feel and see the swelling of the

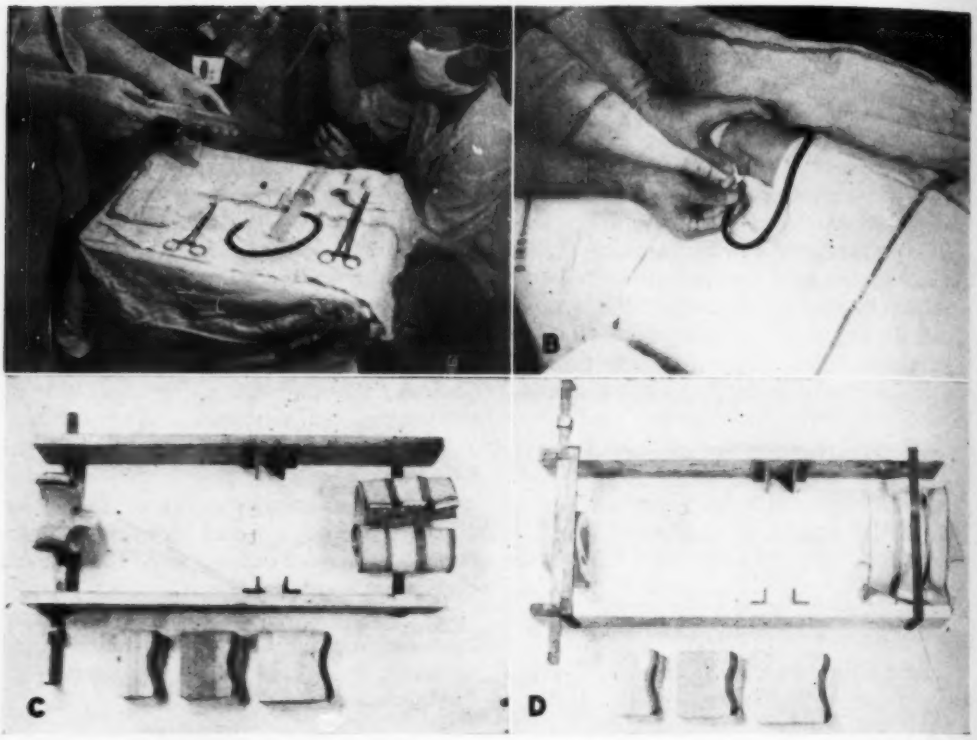


Fig. 2. Steps in the technic of oxygen injection and radiography. A. The adapter for loading the syringe with oxygen is handed to the assistant for connection with the oxygen tank. B. The skin is prepared as for any surgical procedure and the knee is draped. The patella is pushed laterally as the needle is inserted near its superior articular margin. C and D. Knee-spreading device viewed from above (C) and below (D).

suprapatellar bursa. The injection is continued to the point of initial discomfort and slight positive pressure in the joint. The needle is quickly withdrawn and finger pressure is applied over the point of entry for several minutes to seal the opening in the bursa. Gentle massage and movement of the knee will facilitate the circulation of the oxygen through the joint.

Method of X-ray Examination: In order to distribute the air in the joint, and to prevent its loculation in the suprapatellar bursa, the patient is turned into the prone position and the knee is massaged and flexed several times. The patient is then transported to the x-ray examining table.

Evans (14) has indicated that spreading the medial joint space allows visualization of the semilunar cartilages in about 70 per cent of cases even without contrast material in the joint. McGaw and Weckesser demonstrated the additional value of oxygen in the joint. The original method of spreading the joint was a manual one and exposed the x-ray technician to unnecessary hazard. Several new devices have been designed to accomplish this same result by mechanical means. Such a device is shown in Figure 2, C and D. The ankle and thigh are placed in bands, and the ankle is moved laterally, and then medially, about a block of wood placed along the lateral or medial margin of the knee joint (Fig. 3). This widens the joint space on the opposite side of the block in turn for the separate exposures.

In order to obtain a clear visualization of the menisci, it is important that the tibial plateau be perfectly perpendicular to the film. In the average patient, this is

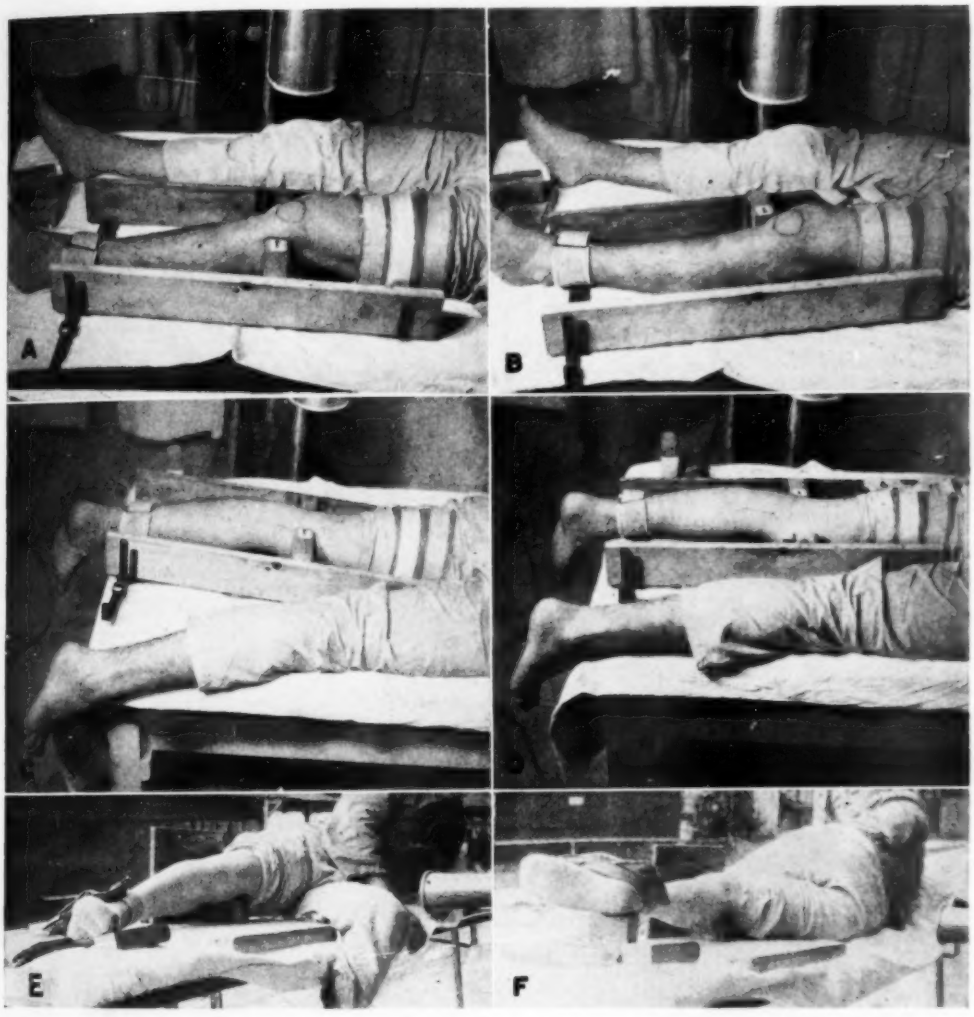
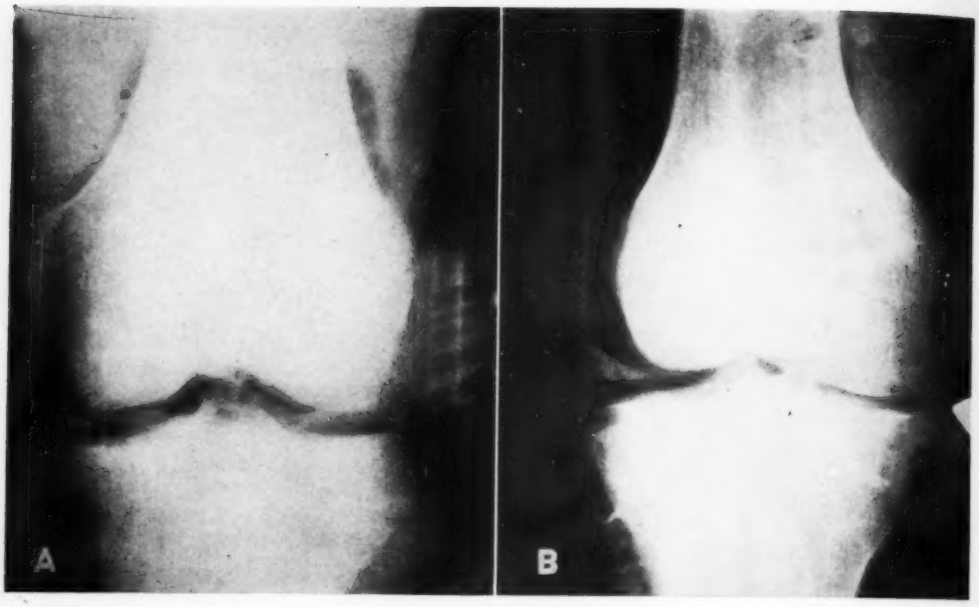


Fig. 3. Further steps in technic. A. Spreading the medial side of the knee joint, anteroposterior view. B. and C. Spreading the lateral side of the knee joint, anteroposterior and postero-anterior views. D. Spreading the medial side of the knee joint, postero-anterior view. E and F. Spreading the lateral (E) and medial (F) sides of the knee joint over a fulcrum and employing a horizontal x-ray beam.

usually accomplished by centering about 1/2 inch below the inferior tip of the patella, or by palpating and marking the upper margin of the tibia. An alternate method is to mark the patient under fluoroscopic control.

The following views are routine: (1) anteroposterior, spreading the medial side of the joint with block pressure laterally (Fig. 3, A); (2) anteroposterior, spreading the lateral side of the joint with pressure medially (Fig. 3, B); (3) postero-anterior, spreading the medial side of the joint space with pressure laterally (Fig. 3, C); (4) postero-anterior, spreading the lateral side of the joint space with pressure medially (Fig. 3, D); (5) a straight lateral view with the knee partially flexed.

The usual factors employed are, for the anteroposterior and postero-anterior views, 55 kv.p., 15 ma., 0.25 second, 30 inch distance, par-speed screens, small focus; for



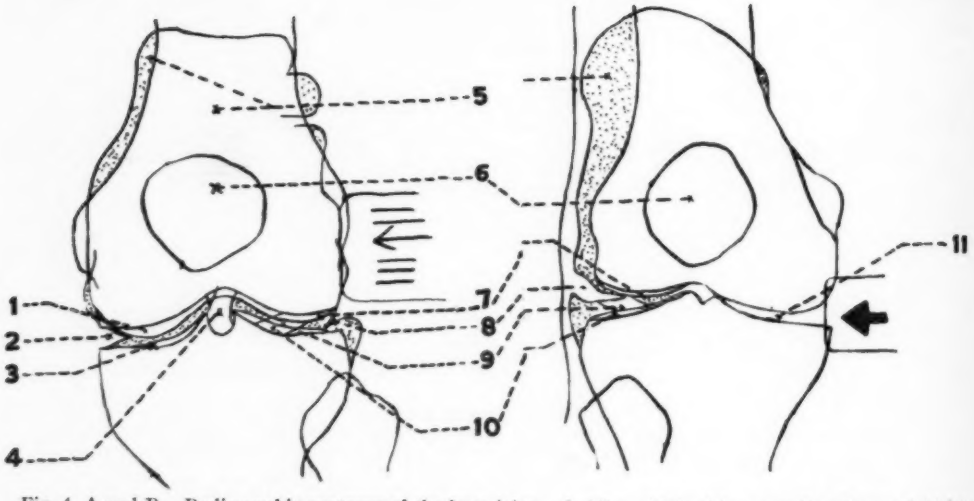


Fig. 4, A and B. Radiographic anatomy of the knee joint. A. View obtained by spreading the medial joint space. B. View obtained by spreading the lateral joint space.

The labeled drawings correspond with the roentgenograms above. 1. Cartilage of medial femoral condyle. 2. Medial meniscus. 3. Cartilage of medial tibial condyle. 4. Cruciate ligament. 5. Suprapatellar bursa. 6. Patella. 7. Cartilage of lateral femoral condyle. 8. Lateral meniscus. 9. Popliteus muscle. 10. Cartilage of lateral tibial condyle. 11. Medial joint space.

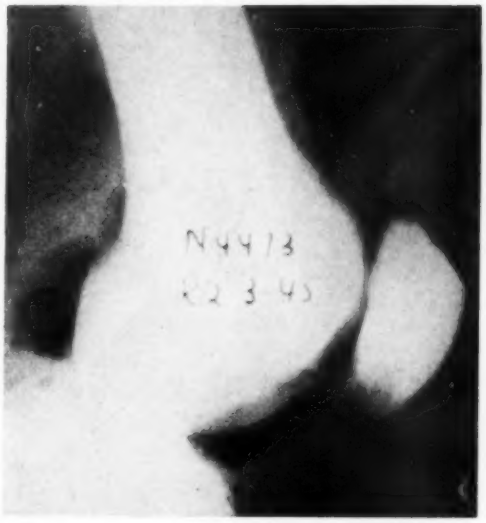
lateral view, 51 kv.p., with other factors as above.

When the usual supine and prone film studies fail to give a sufficiently accurate visualization of the menisci, excellent visualization can usually be obtained by turning the knee on one side or the other, allowing the oxygen to rise to the top, spreading the knee in the usual fashion over a block which acts as a fulcrum, and directing the x-ray beam horizontally through the joint (Fig. 3, E and F). The cassette

is supported perpendicular to the table top, anterior or posterior to the knee, as the case may be.

A fluoroscopic spot-film technic has also been employed, and this method may be very satisfactory if an adequate film-target distance is employed. In the average case, however, this adjunct is unnecessary.

We feel that the routine examination should include both prone and supine studies and that other methods need be used only as accessories when the routine methods fail. The radiologist must treat each case as an individual problem, and check all films carefully until a diagnostic result is obtained, if the injection has been satisfactory. Occasionally every means at our disposal will be necessary. In the case of a poor injection, subcutaneous emphysema, or excessive fluid in the joint, which may interfere with visualization, one need not hesitate to repeat the entire procedure on another occasion.



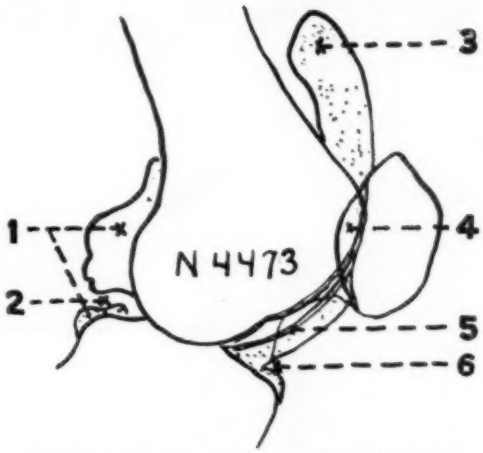


Fig. 4, C. Direct lateral view and tracing of knee joint. 1. Posterior pouches. 2. Posterior septum. 3. Suprapatellar bursa. 4. Cartilage of patella. 5. Infrapatellar fat pad. 6. Ligamentum mucosum.

THE NORMAL PNEUMOARTHROGRAM

The accompanying figures and diagrams (Fig. 4, A, B, and C) show the structures of the knee as outlined on a normal pneumoarthrogram. The structures which can be clearly detected are: the suprapatellar bursa; the infrapatellar fat pad; the medial meniscus (semilunar cartilage); the lateral meniscus; the popliteal bursa. Structures which can be delineated fairly well, but not sufficiently accurately for diagnosis, are: the synovial reflection over the popliteus muscle; the crucial ligaments; the articular cartilage covering the femoral condyles, tibial condyles and the patella; the posterior septum.

A popliteal bursa (Baker's cyst) communicating with the posterior joint space is normally seen in about 13 per cent of cases, and apparently may or may not have pathological significance, depending upon whether or not it is subject to inflammation or obstruction at its neck. Inflating this bursa with oxygen is a definite aid in its surgical excision.

The Suprapatellar Bursa or Pouch: The suprapatellar bursa is best visualized on the lateral projection. However, when it contains a space-occupying lesion (not calcified) such as a synovioma, the latter may be seen quite distinctly on the posteroanterior projection as well (see p. 689). In the lateral view, the suprapatellar bursa is seen as an ovoid structure above the patella, communicating with the rest of the joint. The bursa may have one or more thin folds passing through it (Fig. 5, A), or it may be unilocular. The floor of the

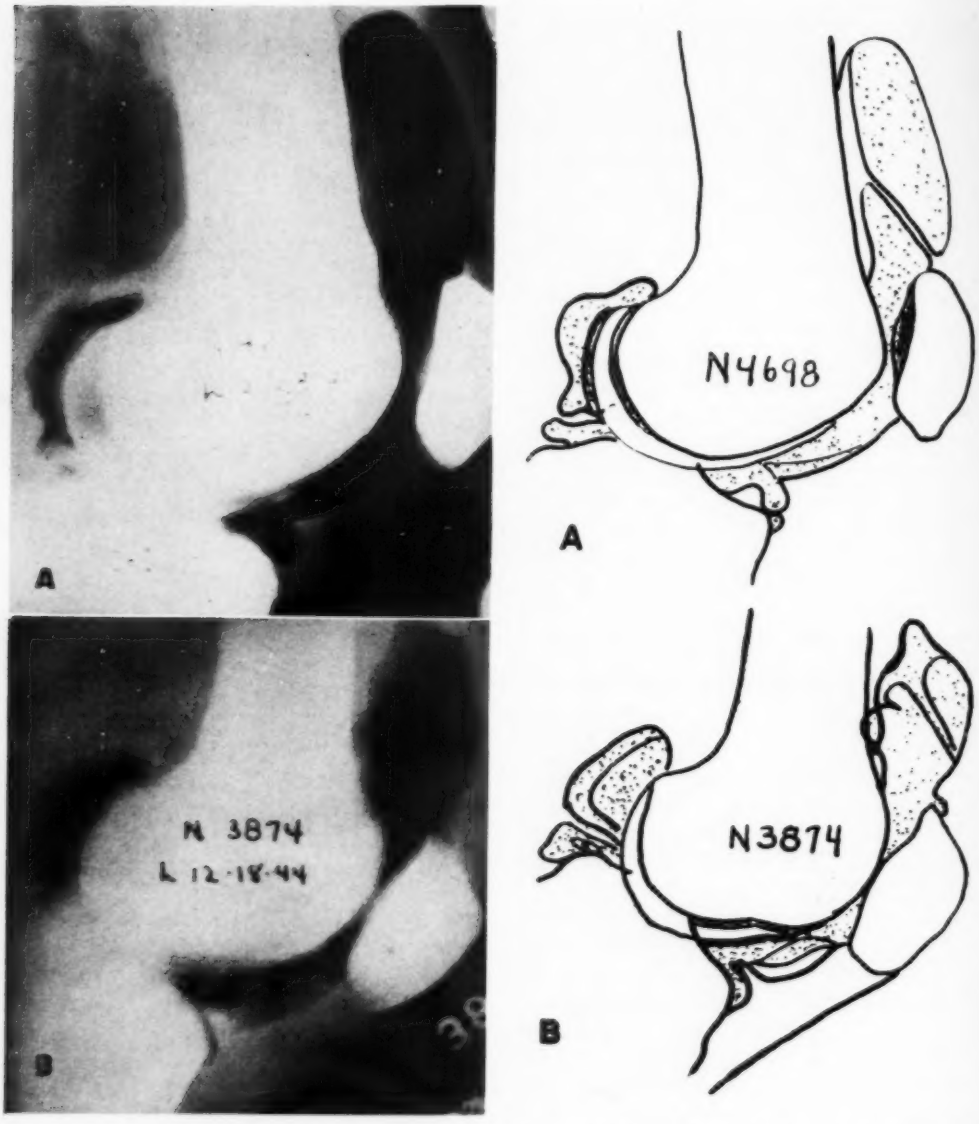


Fig. 5. Variations of lateral view. A. Synovial fold frequently seen in suprapatellar bursa. B. Somewhat irregular but normal suprapatellar bursa.

bursa may be straight or have a scalloped appearance due to loose areolar extrasynovial fat (Fig. 5, B). It may vary in size considerably in the lateral projection, from 3.5 by 2.0 cm. to 6.0 by 4.0 cm. In the postero-anterior (or anteroposterior) projection this structure when distended appears slightly wider than the distal end of the shaft of the femur over which it is projected.

The Infrapatellar Fat Pad: The infrapatellar fat pad is seen in the lateral view as a somewhat irregular triangular structure (Fig. 4, C), which may have a double-contoured appearance, extending between the inferior articular margin of the patella

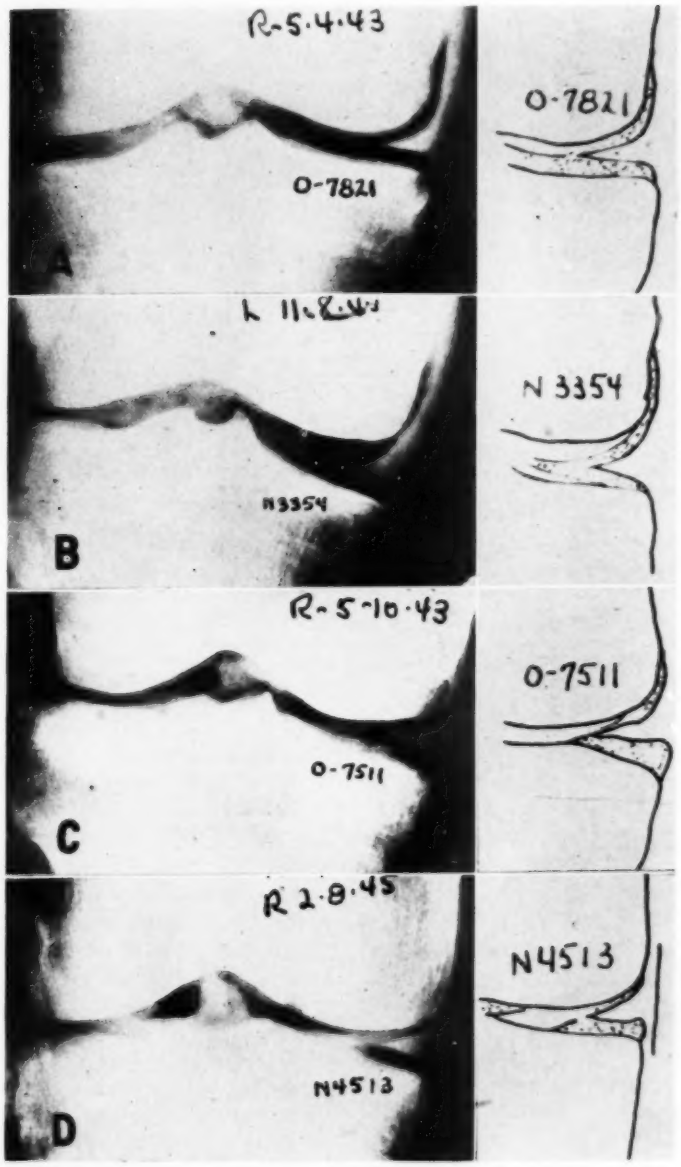


Fig. 6. Variations of normal medial meniscus. A. The meniscus forms a regular triangular shadow of variable length. B. The meniscus forms a regular triangular shadow, but there is a laxity of the medial coronary ligament. C. The meniscus shadow has a somewhat undulating superior and inferior margin, and is variable in length. D. The meniscus shadow has a small notch along the inferior margin of the base of the meniscus. See also Fig. 7.

and the anterior articular surfaces of the condyles of the femur and the tibia. Anteriorly, its shadow blends with that of the quadriceps tendon. The portion which extends into the joint posteriorly (ligamentum mucosum) is pointed, but, as a rule, quite smooth. The ligamentum mucosum is usually several millimeters superior and

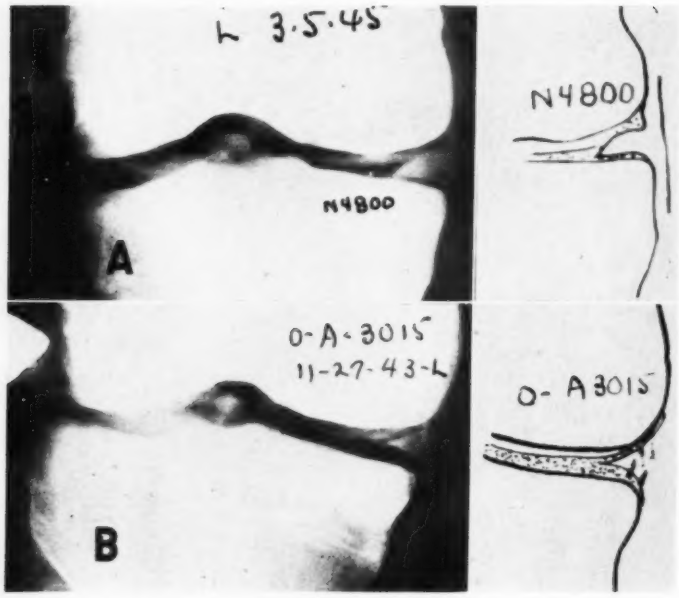


Fig. 7. Further variations of normal medial meniscus. A. A small notch along the superior margin of the base of the meniscus. B. Extraneous air shadows overlying the shadow of the meniscus.

posterior to the anterior margin of the tibial plateau. When viewed under a bright light, several rounded portions may be seen to be superimposed upon the posterior oblique margin of the pad. This appearance, when marked to the point of almost complete obliteration of the anterior joint air space, is indicative of hypertrophy, chronic inflammation, or interstitial hemorrhage (see p. 689). The shadow of the pad is rather homogeneous; when occasionally it assumes a speckled appearance, inflammation is usually the cause. The pad measures, as a rule, about 2.0 by 3.5 cm. in the lateral view.

The Medial Meniscus: The medial meniscus is clearly demonstrated on all the views where the medial side of the joint is spread. Its posterior attachment in the vicinity of the posterior septum is demonstrable on the lateral view. Its normal appearance varies considerably, but within the confines of a fairly definite pattern. This structure as seen on the roentgenogram is a profile of its mid-portion. It is triangular (Fig. 6), with its base firmly attached to the medial collateral ligament of the knee joint. Its pointed apex (free margin) is projected in the joint space between the medial and femoral condyles. Its free surfaces are perfectly smooth. It measures 1.0 to 1.5 cm. in length and 3.0 to 5.0 mm. at its base. Its upper and lower surfaces are usually symmetrical and can be clearly demarcated from adjoining structures. Normally it has a definitely homogeneous density throughout.

The various limits of normal are difficult to describe and can be ascertained best by analyzing a large group of normal studies. This has been attempted in the accompanying illustrations (Figs. 6 and 7). The medial coronary (collateral) ligament may be partially torn, and yet the meniscus may be entirely normal (Fig. 6, B). The meniscus may vary in size and may have a somewhat undulating superior margin (Fig. 6 C); it may be slightly notched at its base inferiorly (Fig. 6, D), or superiorly (Fig. 7, A). Extraneous air shadows may be projected over it (Fig. 7, B). One must have a clear conception of the normal be-

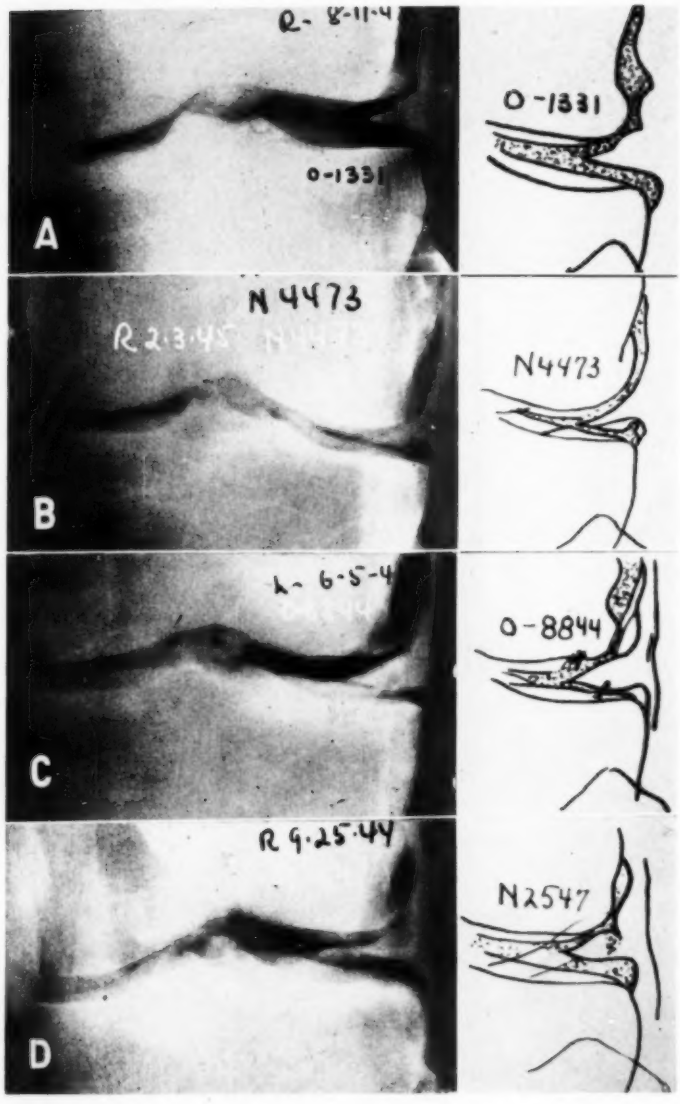


Fig. 8. Variations of the normal lateral meniscus. A. Step-like superior margin. B. Small notch along the inferior margin of the base of the meniscus. C. Broad triangular shadow. D. Small notch along the superior margin near the base. See also Figs. 9 and 10.

fore attempting to determine the abnormal; even so, thus far, certain errors have been found to be inevitable. These will be described in greater detail later.

The Lateral Meniscus: The lateral meniscus is seen to best advantage on those views where pressure is applied medially and the lateral joint space is spread. This meniscus varies considerably in appearance. Its attachment to the lateral coronary ligament is broader than that of the medial meniscus and, in contrast to the latter, there is usually an air shadow between the meniscus and the ligament, due to the fact that there is no capsular attachment where the synovia is reflected around

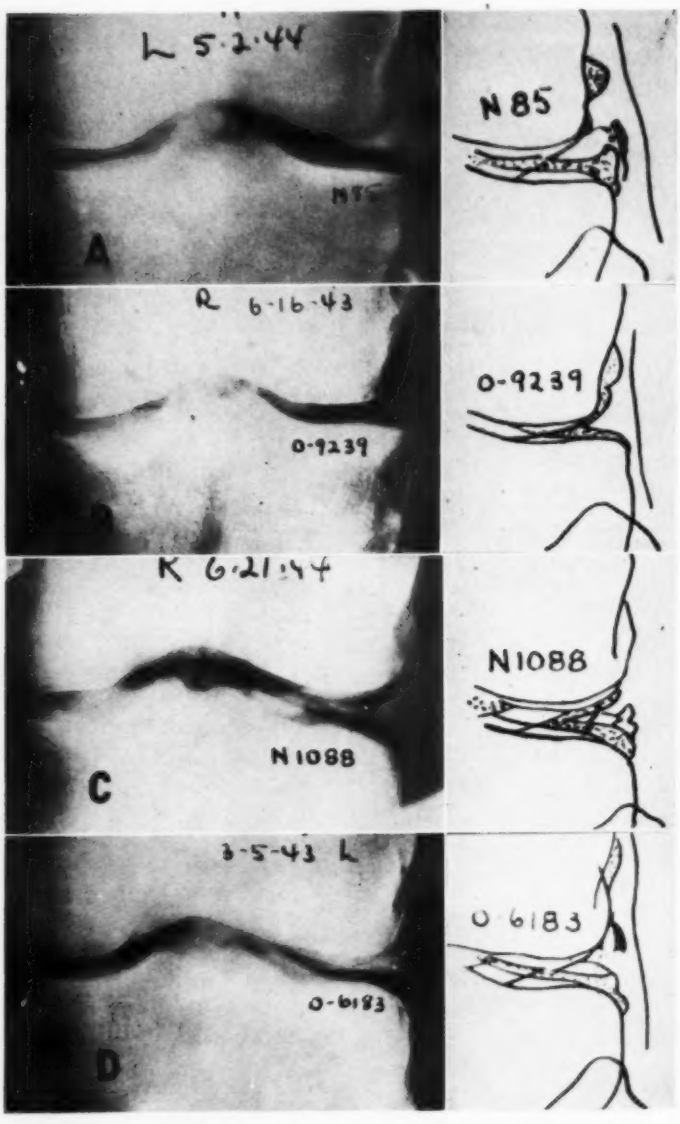


Fig. 9. Further variations of the normal lateral meniscus. A. Small notch at both the superior and inferior margins of the base. B. Short, regular, triangular shadow. C. Oblique extraneous air shadows projected over the meniscus shadow. D. Air shadow at the base of the meniscus.

the popliteus muscle (Fig. 9, D). This meniscus is usually more oblique in position, its base being superior to its free edge. It is usually somewhat longer in profile view than the medial meniscus, and not quite so regular in contour (Figs. 8 and 9).

The numerous variations of the normal lateral meniscus are illustrated in Figures 8, 9, and 10. It will be noted that there may be a single or double air shadow at the base, or none at all. Some of these air shadows are due to subcutaneous emphysema, while other shadows are more difficult to interpret. The meniscus may be

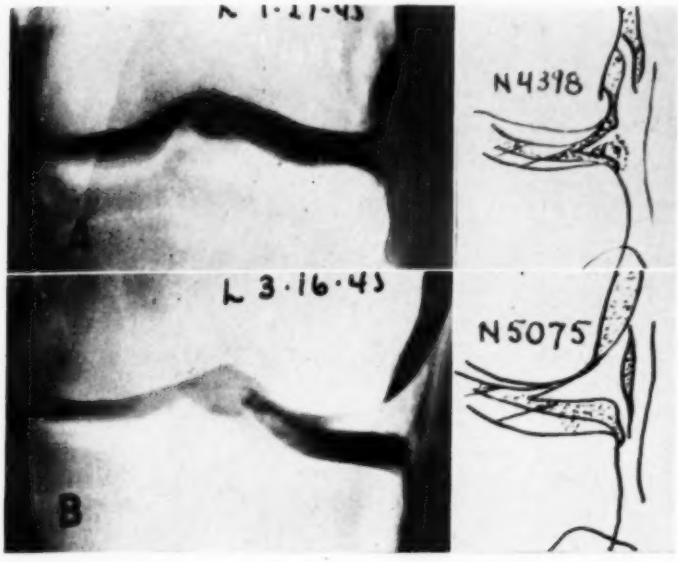


Fig. 10. Further variations of the normal lateral meniscus. A. Irregular extraneous air shadows projected over the base of the meniscus shadow. B. Extra-articular air shadow projected outside the base of the meniscus.

oblique or transverse. Its superior margin may be step-like (Fig. 8, A) instead of straight. There may be a small notch along the inferior margin near the base (Fig. 8, B) or along the superior margin (Fig. 8, D), or both inferiorly and superiorly near the base (Fig. 9, A). A double-contoured appearance may result if more of the free edge is seen than in the usual transverse section. The meniscus may vary considerably as to size, but it is seldom very short normally (Fig. 9, B).

There are also more confusing air shadows on the lateral side of the joint than are found medially (Fig. 9, C and D; Fig. 10, A and B). The popliteus muscle casts its shadow here and must be delineated. It not infrequently obscures the shadow of the free edge of the meniscus. The usual oblique shadow of the meniscus frequently overlaps the shadow of the lateral femoral condyle somewhat, but with good technic can be clearly shown. The shadow of the lateral meniscus is less apt to be as homogeneous as that of the medial meniscus.

Despite this great variety of normal appearances, our errors with regard to the lateral meniscus have been only slightly more frequent than with regard to the medial. This is probably due to the fact that minimal changes in the appearance of the lateral meniscus are regarded as less significant than similar alterations in the appearance of the medial.

The Posterior Capsular Pouches: The posterior capsular pouches are usually quite small with a linear septum extending obliquely through them. They are bilocular and projected directly between the posterior adjoining margins of the femoral and tibial condyles. The over-all measurements of the pouches are usually in the vicinity of 2.5 by 1.5 cm. We have never had occasion to diagnose abnormality of these structures *per se*.

A popliteal bursa or cyst (Fig. 33), when present, usually communicates with the superior locule of the popliteal space by a narrow communication up to 1 cm. in length. This structure may or may not contain fluid, and may be unilocular or multilocular. It varies considerably in size, anywhere from 1 cm. to 5 or 6 cm. in diameter. It may be ovoid, scalloped, or spherical in shape. It occurred in 13.5 per cent of all of our cases and is probably

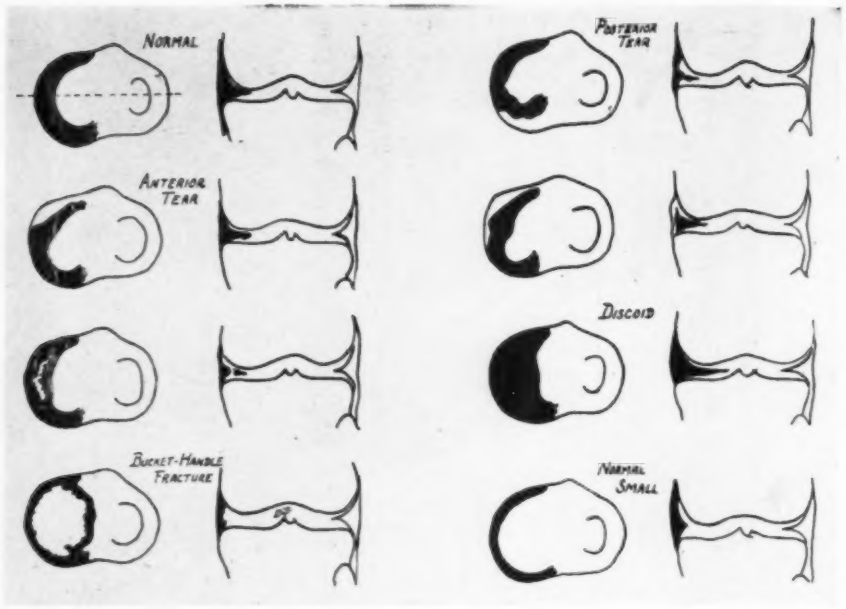


Fig. 11. Comparison studies of menisci and appearance of pneumoarthrograms. Top view of menisci and anteroposterior films.

without pathological significance, unless it is subject to inflammation and its communication with the joint closes off intermittently. A popliteal cyst was removed in only 7 out of the 106 cases in which it was noted (6.6 per cent).

The Popliteus Muscle: The popliteus muscle, covered by a synovial fold, may be seen on the postero-anterior and anteroposterior projections extending obliquely across the lateral joint space. Its usual measurements on these projections are 1.5 cm. by 5.0 mm. Its shadow sometimes overlaps that of the free margin of the lateral meniscus, producing a confusing appearance if one is not aware of its presence. We have not detected any pathologic process in this structure.

The Crucial Ligaments: The crucial ligaments are usually projected above the tibial spines in the anteroposterior and postero-anterior views. We have not been able to visualize these sufficiently distinctly to diagnose tears, although tears have been described by others. A chip fracture in the vicinity of the tibial spines has been found to be associated with crucial tears on several occasions (see p. 697), but ordinary roentgenograms are better in this event than pneumoarthrograms.

Articular Cartilage Covering the Femoral, Tibial, and Patellar Condyles: The cartilage overlying the femoral, tibial, and patellar condyles can be detected as a thin layer overlying the bony substance. In the case of the femoral and tibial condyles, this is usually 3 to 4 mm. in width, varying roughly with age. The patellar cartilage, seen only on the lateral view, is thicker, the thickest portion being the mid-section, where it may measure as much as 8 mm.

We have one word of caution: *Air shadows may actually interfere with accurate bony structure visualization. One should not use pneumoarthrograms as a substitute for plain roentgenograms of the knee.*

THE ABNORMAL PNEUMOARTHROGRAM

The Suprapatellar Bursa: Two types of abnormality have been observed in the suprapatellar bursa: obliteration, partial or almost complete, usually the result of

inflammation or suppuration following an injury (Fig. 31) and tumor (synovioma) (Fig. 32).

Obliteration manifests itself as partial absence of the bursa or a speckled appearance. A certain amount of difficulty may be encountered in injection of the gas, and it is noted that the joint will take comparatively little oxygen, as little as 15 c.c. in one of our cases.

The synoviomas we have observed were visualized on both the postero-anterior and lateral projections as spherical structures about 1.5 cm. in diameter. These must be differentiated from those cases where the floor of the bursa appears slightly elevated or scalloped. In the latter instance, there is no abnormality detected in the postero-anterior projection, and this is used as the differentiating feature.

The Infrapatellar Fat Pad: As the result of inflammation or fibrosis from one cause or another, there have been observed in the infrapatellar fat pad three general types of pathologic change which may be manifest on the films.

(1) The fat pad may appear larger than normal, as indicated by diminished oxygen in the infrapatellar region, due either to hypertrophy or fibrosis, chronic inflammation, hematoma, or contusion. In such instances, the appearance is that of an enlarged, scalloped structure with free fringes in the lateral view (Fig. 29), and very little oxygen appears in the anterior joint space. It has been found that not all cases where the fat pad appears enlarged on the film prove to be abnormal at operation; *vice versa*, not all cases that are found to be abnormal at operation appear so on the film. It is hard to assay the accuracy of the radiographic diagnosis in these cases, since even at operation it is frequently difficult to determine whether or not the structure is abnormal. In any event, in the great majority of cases, abnormality of this fat pad is not in itself the major indication for arthrotomy.

(2) The fat pad may be torn, with loose fringes lying free in the joint space (Fig. 27).

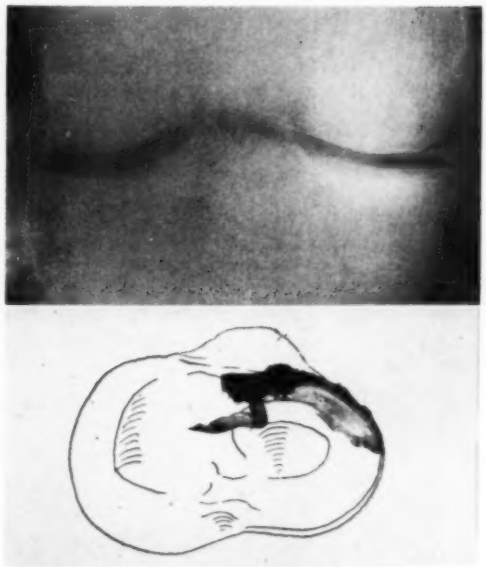


Fig. 12. Dislocation-tear of meniscus. Actual specimen superimposed on a diagram of the tibial plateau and the corresponding roentgenogram. Only one-half of the meniscus was removed.

(3) A portion of the fat pad may be adherent to one of the cartilaginous structures in the knee joint as the end-result of inflammation (Fig. 30). This diagnosis cannot be made with accuracy from film studies alone. If the ligamentum mucosum has a long fringe extending far into the anterior joint space, downward toward the tibia, this diagnosis is suggested.

Abnormalities of the fat pad are probably of symptomatic significance in many cases. In several instances in our series, these were the only findings at operation to explain the patients' complaints. These are usually cases with recurrent synovitis and no history of locking or clicking.

The Abnormal Medial Meniscus: Fractures or tears can occur in any part of the medial meniscus; hence its abnormal appearance is extremely variable (Figs. 12–15). In the great majority of cases, however, one has little difficulty in making the diagnosis, since the abnormal appearances fall into fairly definite patterns. Since the limits of normal are not so wide in the case of the medial meniscus as in the lateral, one can feel more secure in the diag-

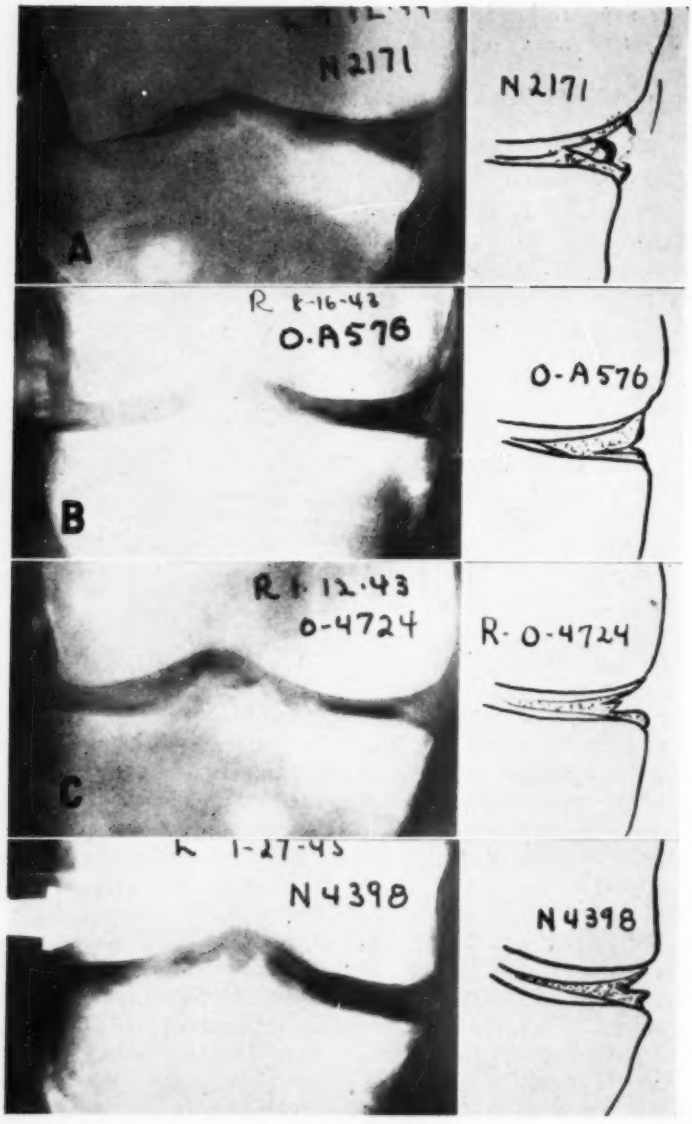


Fig. 13. Pathological variations in the medial meniscus. A. The meniscus shadow is fragmented. B. The meniscus shadow is virtually absent, indicating a fracture-dislocation of the bucket-handle type. C. The free edge of the meniscus is frayed and shortened. D. The meniscus shadow is short and blunt, also indicating a bucket-handle type of fracture. See also Figs. 14–16.

nosis of medial meniscus abnormalities. The accompanying comparison diagram (Fig. 11) will prove helpful in visualizing the pathologic changes which are demonstrable roentgenographically.

The meniscus shadow may appear fragmented as in Figure 13, A. Its outline may be virtually absent due to fracture-dislocation of the meniscus, as in bucket-handle fractures (Fig. 13, B). The free edge of the meniscus may appear frayed and shortened (Fig. 13, C) or short and

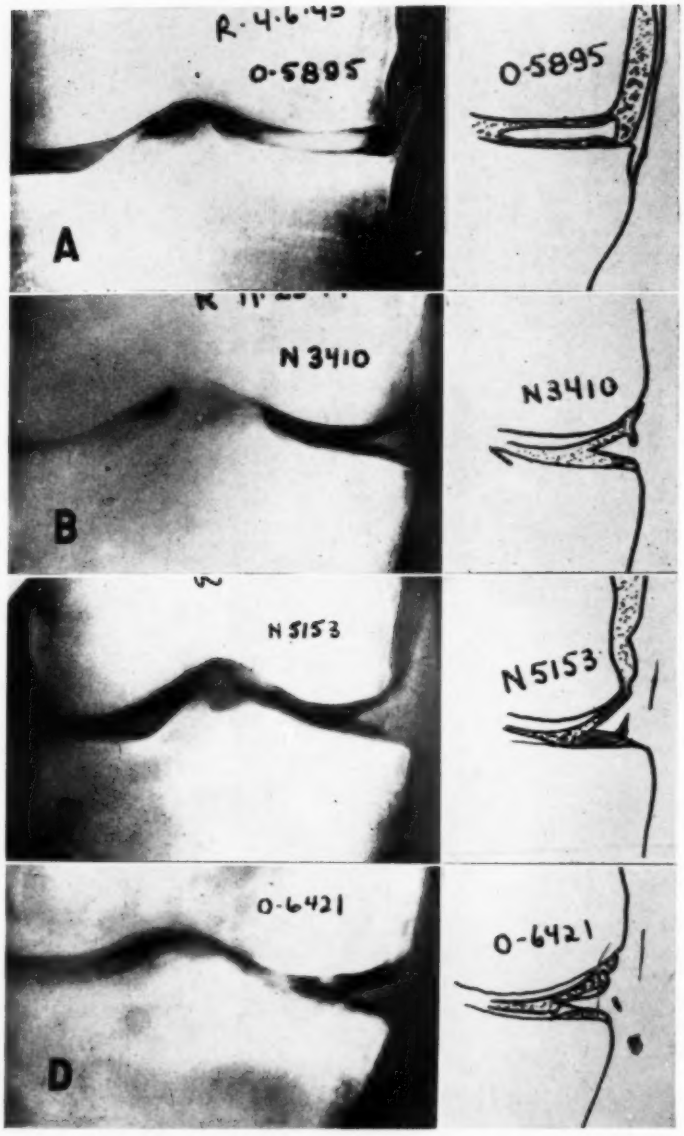


Fig. 14. Further pathological variations in the medial meniscus. A. An obvious tear at the base of the meniscus shadow. B. A notching of the superior margin at the base of the meniscus due to an incomplete tear. C. Notching of the inferior margin of the base of the meniscus due to incomplete tear. D. The free margin of the meniscus shadow presents a crossed appearance.

blunt (Fig. 13, D). There may be a tear at the base of the meniscus (Fig. 14, A). The meniscus may be partially torn along its superior attachment (Fig. 14, B), or inferior attachment (Fig. 14, C). The free margin may show a crossing of fragments (Fig. 14, D), or it may be rounded (Fig. 15, A). There may be a fracture through the base of the meniscus shadow (Fig. 15, B).

There are other appearances of the men-

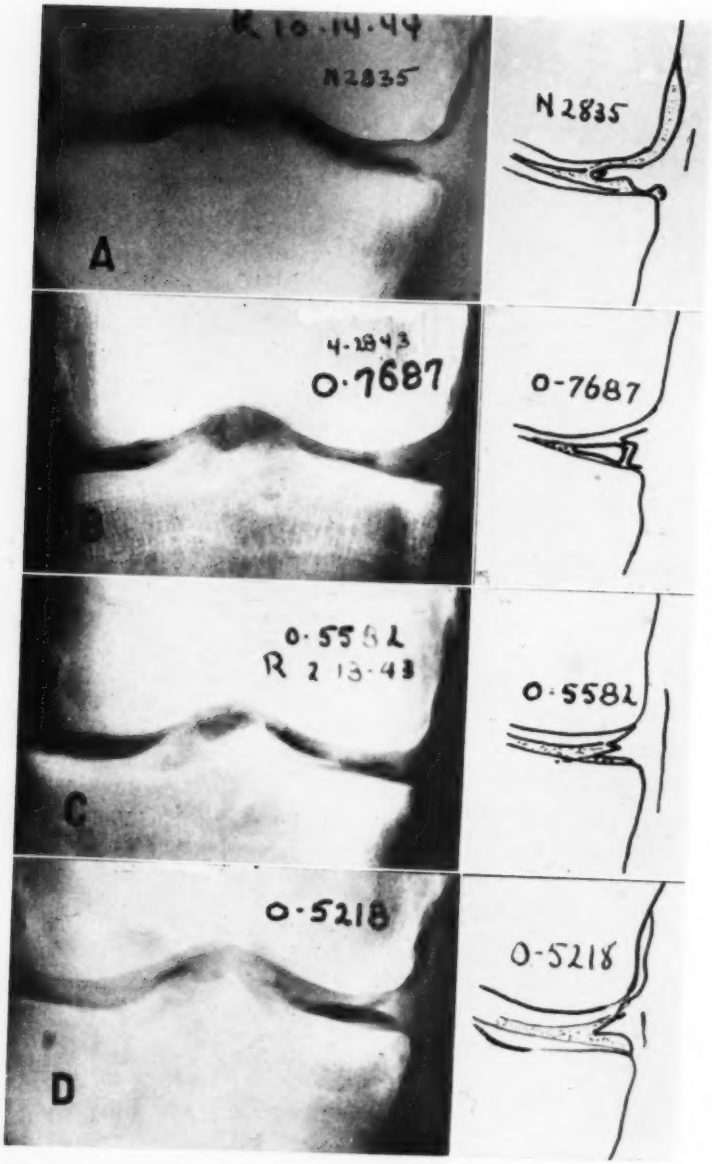


Fig. 15. Further pathological variations in the medial meniscus. A. Rounded appearance of the free margin of the meniscus, indicating fraying. B. Fracture through the base of the meniscus shadow. C. The free margin of the meniscus presents a notched appearance. D. The superior margin of the meniscus has a step-like notched appearance, with evidence of fracture.

iscus which indicate abnormality, but the exact pathology cannot always be predicted. The superior or inferior margin, or both, may appear irregular, jagged, and serrated (Fig. 15, D). The apex of the meniscus may have a serrated contour (Fig. 15, C). The meniscus may also appear somewhat thinned-out and shortened.

Occasionally the type of abnormal appearance will be different on the postero-

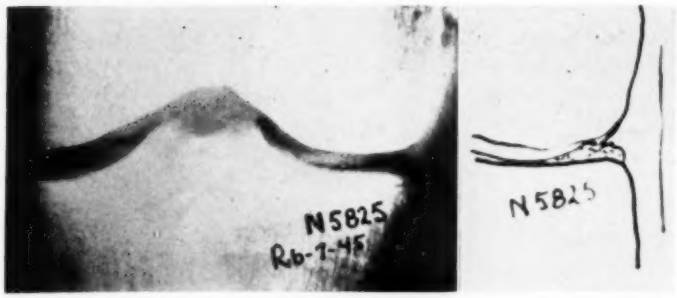


Fig. 16. Appearance of pneumoarthrogram after removal of the medial meniscus.

anterior and anteroposterior projections (Figs. 20 and 21), or the meniscus may appear normal on the one view and definitely abnormal on the other (Fig. 20, A and B). Frequently, when a meniscus appears questionable the first time, a repeat examination at a later date will decide the issue quite definitely one way or another (Fig. 22).

As previously indicated, our most frequent errors with regard to the medial meniscus pertain to fractures of the cornua, especially when this type of fracture is either anterior or posterior. Routine views which theoretically might show these fractures do so only if there is a secondary irregularity of the mid-section of the meniscus as well. Otherwise, the meniscus in these instances appears normal (Fig. 34, A). Also, as previously indicated, the normal very short blunt meniscus simulates the appearance of the bucket-handle type of fracture (Fig. 34, C). Fortunately, this type of anomaly is rare.

The Abnormal Lateral Meniscus: As in the case of the medial meniscus, the abnormal lateral meniscus varies considerably in appearance. Due to the greater variation of the normal, however, and to interfering shadows, diagnosis of abnormality is more difficult.

The lateral meniscus may have irregular, serrated margins (Fig. 17, A).

An air shadow at the base of the lateral meniscus is normal and, for this reason, some tears at the base of the meniscus will be missed. When this air shadow is abnormally wide, however, or incomplete, especially along the inferior margin of the base, it can be presumed to be abnormal, usually indicating a tear (Figs. 17, B and 18, A).

As in the case of the medial meniscus, an absent or short blunt meniscus shadow is indicative of either dislocation-fracture (bucket-handle fracture) (Fig. 17, C) or surgical excision (Fig. 22, C and D), and the two conditions cannot be distinguished radiographically. The distinction is so readily made, however, by history and physical examination that it never presents much of a problem. Not all bucket-handle fractures have this appearance; they may assume other abnormal appearances, as described.

Fracture lines through any portion of the meniscus can also be detected. These may be vertical, horizontal, or oblique (Figs. 17, D and 18, A).

The diagnosis of cyst of the lateral meniscus has been made on five occasions in our series (Figs. 18, B and C). In one of these, the meniscus, in addition to being cystic, was also fractured (Fig. 18, C). In these cases there is usually a palpable enlargement at the base of the meniscus laterally, and the radiographic diagnosis of the cyst is often corroborative; however, in one case, in an obese patient, the diagnosis was made radiographically and proved at operation, but could not be made by physical examination. The appearance is that of a broadening and bulging and generalized enlargement of the base of the menis-

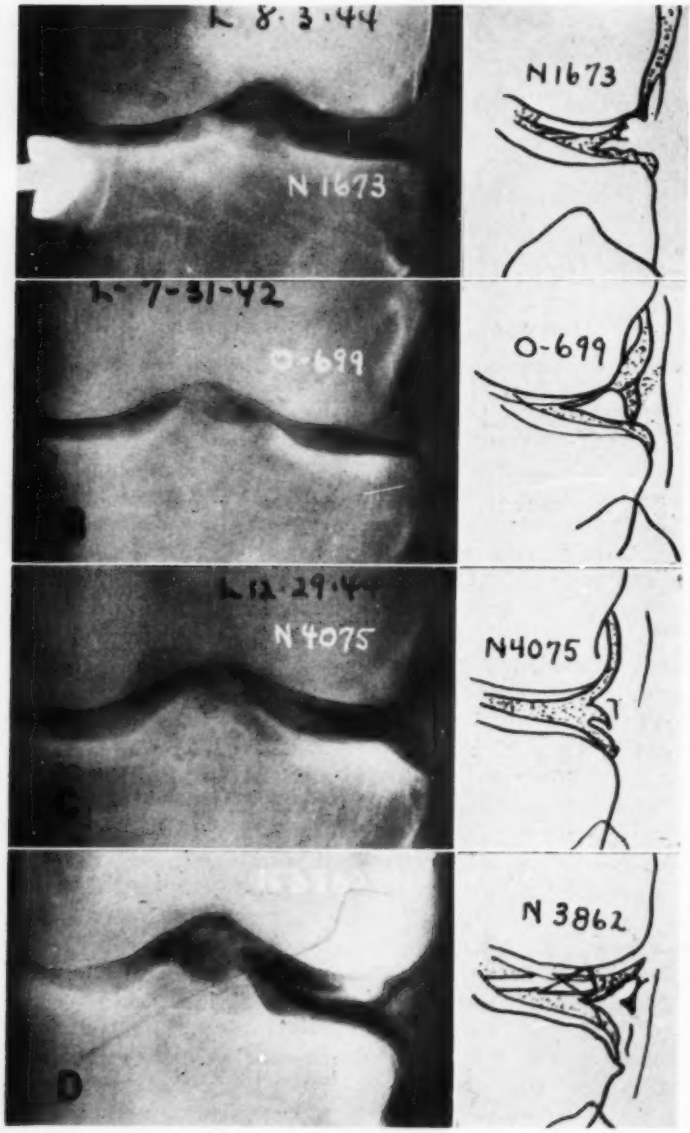


Fig. 17. Pathological variations of the lateral meniscus. A. The superior margin of the shadow is irregular. B. Abnormally wide air shadow at base. C. The meniscus shadow is frayed and short—almost absent. D. Fracture lines traversing the shadow of the meniscus obliquely. See also Figs. 18 and 19.

cus, and sometimes of other portions of the meniscus as well. This finding is of surgical importance, since it indicates the extent of dissection necessary.

A discoid meniscus appears elongated (Fig. 19). Pathologically, these menisci are circular or plate-like (Fig. 11) rather than semilunar in shape, and therefore the transverse section seen on the radiograph extends about two-thirds or more across the tibial plateau on the side in question. Ordinarily, the meniscus shadow occupies only about 50 per cent or less of the lateral or medial joint space.

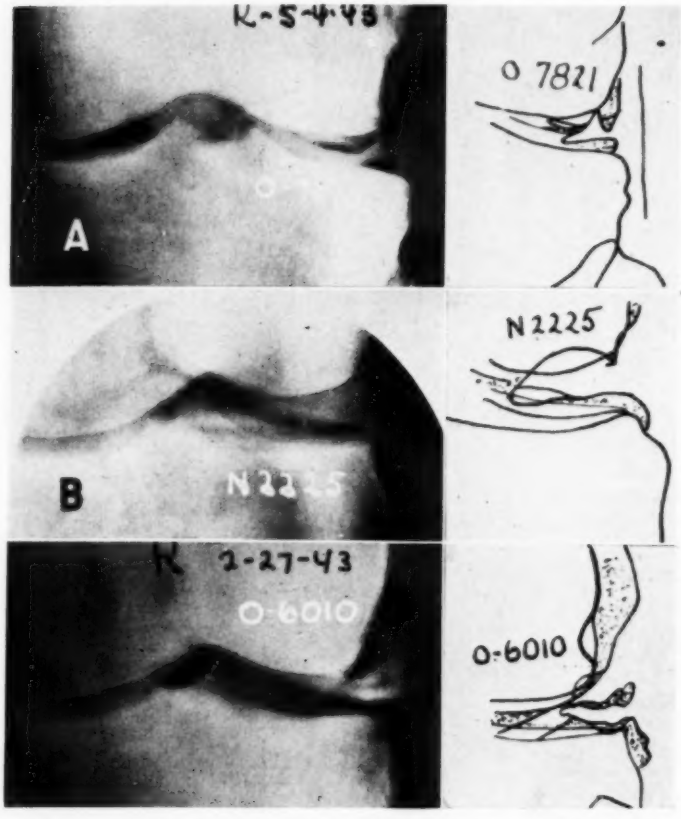


Fig. 18. Further pathological variations of the lateral meniscus. A. Fracture line through base of meniscus. B. Cystic meniscus. C. Cystic and fractured meniscus.

The lateral meniscus may appear different in anteroposterior and postero-anterior projections (Fig. 21, C and D).

OSTEOCHONDRITIS DISSECANS AND CHONDROSIS

It is true that pneumoarthrograms rarely add to the diagnosis of osteochondritis dissecans (Figs. 24 and 25) beyond what is already known from the plain films. The defect may, however, be accentuated by the air shadow and more readily detected. Also, the pneumoarthrogram shows the intrasynovial or extrasynovial position of the separated particles and their size.

Chondrosis of the patellar articular cartilage may be suggested in the roentgenogram by marked sclerosis and indentation of the articular margin and by thinning and irregularity of the cartilaginous shadow as seen on pneumoarthrograms. This diagnosis is not infrequently impossible to make under any condition.

Fig. 19. Discoid meniscus.

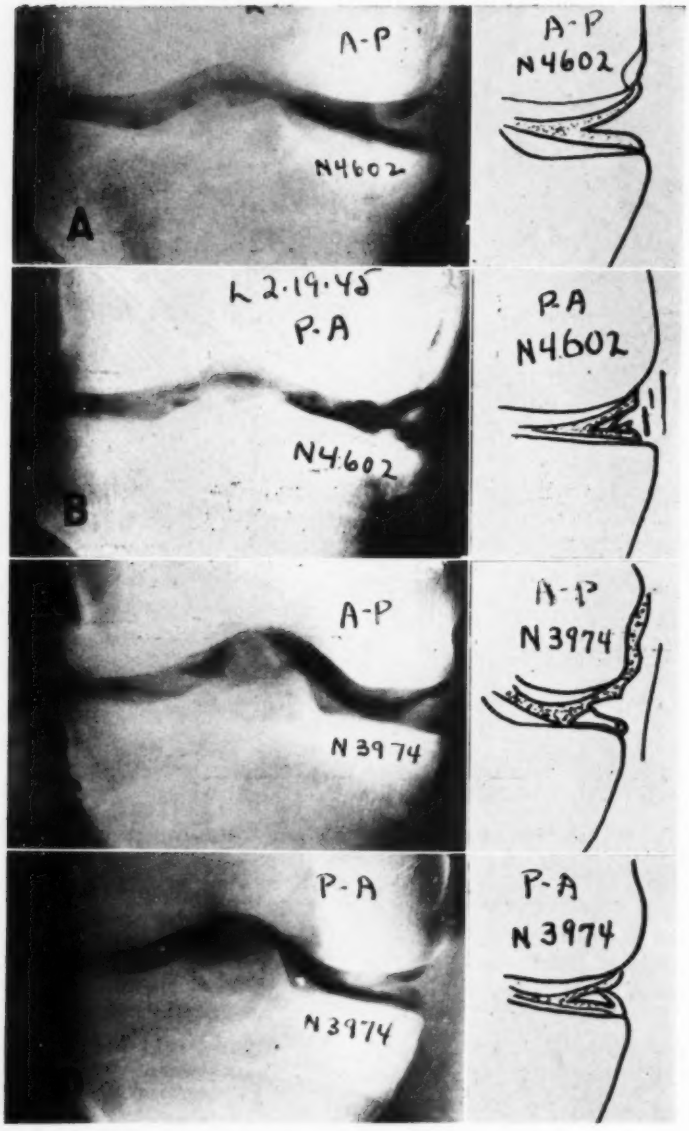


Fig. 20. Differences between anteroposterior and postero-anterior views. A. Anteroposterior view, showing normal appearing medial meniscus. B. Postero-anterior view, showing irregular inferior margin. C and D. Anteroposterior and postero-anterior views showing difference in appearance of oblique fracture lines through body of medial meniscus.

LIGAMENTOUS STRUCTURES

Relaxed medial and lateral coronary (collateral) ligaments can be readily demonstrated because of the spreading technic (see abnormal medial spread in Fig. 6, B). A fairly accurate basis for the diagnosis of relaxation of these ligaments can be achieved.

The findings with regard to torn crucial

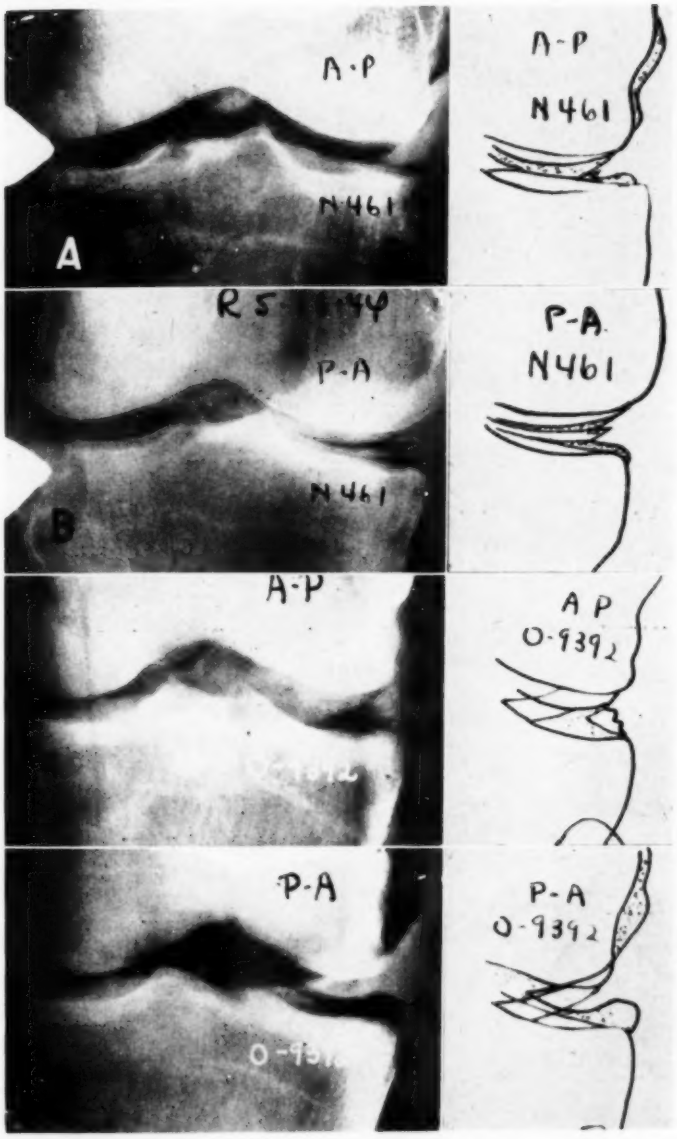


Fig. 21. Differences between anteroposterior and postero-anterior views. A and B. Irregular margin of medial meniscus, appearing differently in the two views. C and D. Relatively normal appearing lateral meniscus (D) seen as shortened and irregular in anteroposterior view.

ligaments have already been discussed. Apart from the appearance of chip fractures in the region of the tibial spines and an air bubble in the vicinity of the ligament, this diagnosis cannot be made radiographically with technic thus far described. We have measured anterior and posterior displacement of the tibia with respect to the femur in the lateral knee films, but that is a subject quite apart from pneumoarthrography.

Crucial ligament tears occurred in 22

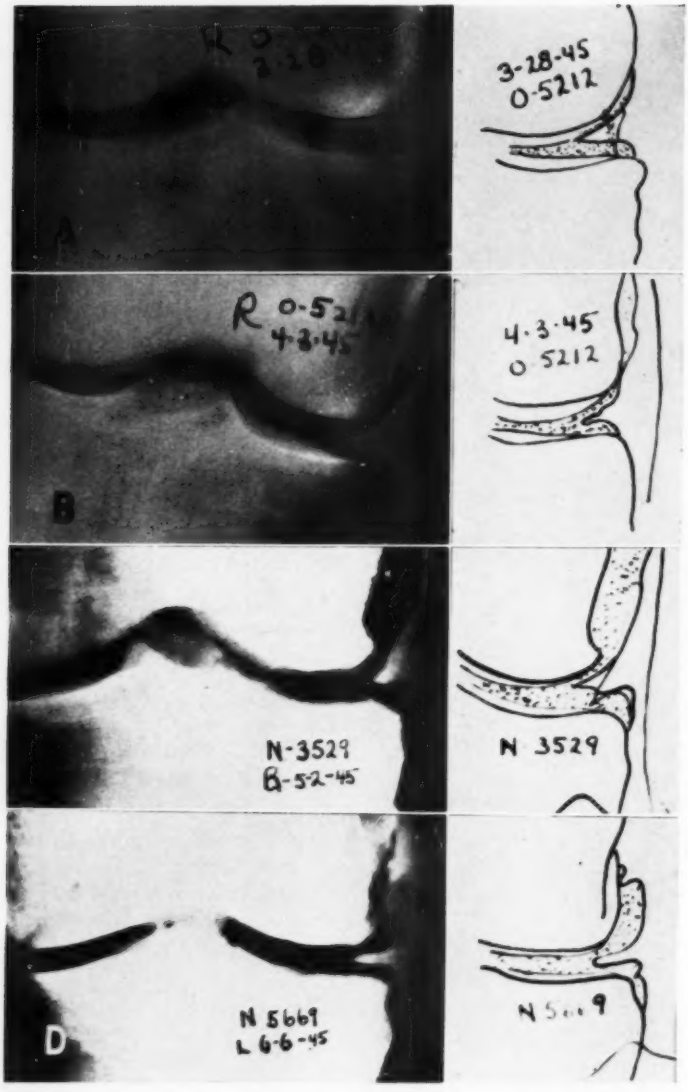


Fig. 22. Changes in appearance of medial meniscus shadow with the passage of time. A. Superimposed air shadow—not definitely abnormal. B. Irregular, frayed meniscus shadow at a later date. C and D. Appearance after the removal of lateral menisci, simulating fracture-dislocation of the bucket-handle type.

cases, or 6.9 per cent of the 315 patients operated upon in our series, usually in combination with meniscal fractures, since this abnormality by itself was not considered adequate indication for arthrotomy in an overseas Army hospital. It occurred alone, with no other demonstrable abnormality, in only 4 cases, or 1.3 per cent.

FLUID IN THE JOINT SPACE

In the presence of a hydroarthrosis, as much fluid as possible should be removed from the knee joint prior to oxygen insufflation. At best, however, a small amount of fluid retention is inevitable, and this may interfere with the accurate visual-

TABLE I: GENERAL STATISTICS

	April 1942–44	April 1944–45	Total
Total pneumoarthrograms	528	254	782 (100.0%)
Operated pneumoarthrogram cases*	230	85	315 (40.3%)
Arthrotomies without previous pneumoarthrograms	34	6	40

* Forty arthrotomies were done without previous pneumoarthrograms for internal derangements, patellar fractures, and removal of foreign bodies.

ization of the internal structures of the joint. We have found that compression bandages over the suprapatellar bursa are usually not necessary, but occasionally enhance the visualization of the menisci. It is best to wait, if possible, until all or most of the fluid is out of the joint before proceeding with the examination. The prone position in such cases usually yields better diagnostic results than the supine (Fig. 23). The lateral position (tube horizontal) is also of value in such cases.

The hazy appearance in supine positions and the clear visualization in the prone furnish an excellent diagnostic criterion of fluid in the joint. In the prone position, the fluid flows into the suprapatellar bursa, leaving the joint space relatively clear.

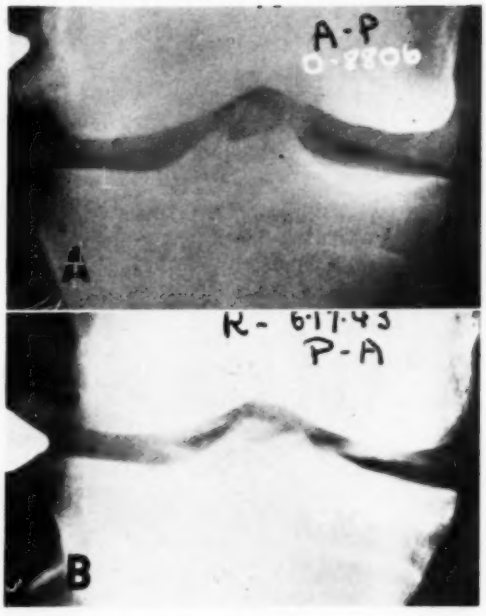


Fig. 23. Appearance in hydrarthrosis. In the anteroposterior view (A) the structures appear blurred and indistinct. In the postero-anterior view (B), the fluid shifts to the suprapatellar bursa and the structures are much more distinct.

STATISTICAL EVALUATION

General Statistics: The period of observation in the series here reported covers the three-year interval between April 1942 and April 1945, inclusive. The total number of pneumoarthrograms of the knee done in this period was 782 (Table I). In the first two-year period, 528 were done, and in the third year, 254. These two intervals are separated in order to determine more accurately the status of the pneumoarthrogram in its more recent stage of development. Only those operated cases have been studied in which pneumoarthrograms were made prior to operation. During the first two-year period, 230 arthrotomies were done on cases which had had pneumoarthrograms previously, and in the third-year period, 85, making a total of 315 operated cases. Forty arthrotomies were done without previous pneumoarthrograms, a few for internal derangement, but the majority for patellar fractures and for the removal of loose bodies.

We have arbitrarily divided the surgical findings at arthrotomy into two types: (*a*) a major type, where the designated finding was the most significant or sole finding at operation; (*b*) a minor type, where the described findings were of lesser importance and in every case occurred with some other finding classified under the major type. Arthrotomies were done because either the clinical or radiographic findings suggested a good prognosis.

In certain cases there were two findings which were considered of major significance. Thus, in 10 cases two abnormal menisci were found either in the same or different knees (Table II). In 4 additional cases other miscellaneous findings made two major diagnoses necessary in each instance. This is very important surgi-

Fig. 24. Appearance in osteochondritis dissecans. Oxygen enters the defect in the medial femoral condyle and produces intensification of the defect. The medial meniscus is also pathological.

Fig. 25. Osteochondritis dissecans. Slight intensification of the defect in the medial femoral condyle by the oxygen. The medial meniscus in this case is normal.

cally and shows the great value of pneumoarthrograms at times, since it is impossible clinically to diagnose a bilateral meniscus tear in the same knee. The procedure also aids materially in preventing the missing of multiple pathologic findings.

In cases of osteochondritis dissecans where a fractured meniscus was also found, the fracture was listed as the major diagnosis unless the osteochondritis was very severe, because, by and large, the pneumoarthrogram is not necessary for a diagnosis of the latter disease.

Thus, in the total 315 cases, because of the duplication of diagnoses in 14, the total number of major pathologic diagnoses was 329: 242 during the first two-year interval and 87 in the third year (Table II).

Incidence of Lesions in Operated Cases with Pneumoarthrograms: An abnormal meniscus was found in 218 cases, 69.2 per cent of the total number of major diagnoses made (Table III). Abnormal medial menisci numbered 155, whereas the lateral numbered 63, a ratio of approximately 5 to 2, or 47.1 per cent as against 19.1 per cent.

Chondrosis of the patella and osteochondritis dissecans were considered major diagnoses in 39 cases, or 11.9 per cent. Loose bodies occurred in 19 of these. The medial femoral condyle was involved in 15, the lateral in 4, and there was a chondrosis of the patella in 20. The high incidence of patellar chondrosis is significant.

Seven popliteal cysts were operated upon, accounting for only 2.1 per cent of the major diagnoses, despite the relatively high incidence of popliteal bursae in general.

TABLE II: CASE DISTRIBUTION OF PATHOLOGIC DIAGNOSES

	April 1942–44	April 1944–45	Total
Total major pathologic diagnoses	242	87	329
Total cases	230	85	315
Cases with more than one major finding	12	2	14
With abnormal menisci	9	1	10
With 2 miscellaneous abnormalities	3	1	4

Loose bodies without demonstrable osteochondritis or chondrosis were considered major findings in 2.1 per cent of the cases.

Arthritis (without other derangement) was the major finding in 3.3 per cent of the series. Crucial ligament tears were the only finding in 1.2 per cent, and an abnormal fat pad in 9.7 per cent. Cases in these three categories were usually treated surgically, with a preoperative diagnosis of some other type of internal derangement. Eight normal knees were operated on (2.4

TABLE III: TOTAL INCIDENCE OF LESIONS IN OPERATED CASES WITH PNEUMOARTHROGRAMS (APRIL 1942–APRIL 1945)

	Major Findings	Lesser Findings	Total	% of 524	% of 315
Abnormal medial meniscus	155	0	155	29.8	49.2
Abnormal lateral meniscus	63	0	63	12.0	20.0
Abnormal fat pad	32	65	97	18.5	30.8
Popliteal cyst	7	41	48	9.1	15.2
Loose bodies without osteochondritis or chondrosis	7	1	8	1.5	2.5
Osteochondritis dissecans and chondrosis	39	41	80	15.2	25.4
Medial femoral condyle	(15)	(21)	(36)	...	...
Lateral femoral condyle	(4)	(6)	(10)	...	...
Patella	(20)	(14)	(34)	...	...
Generalized	(2)	(7)	(9)	...	...
With loose bodies	(19)	(3)	(22)	...	...
Arthritis	11	29	40	7.6	12.7
Crucial ligament tears	4	18	22	4.2	7.0
Miscellaneous	11	0	11	2.1	3.5
Synovioma	(1)	..	..	...	...
Obliterated bursa	(1)	..	..	...	...
Normals	(8)	..	..	...	...
Questionable findings	(1)	..	..	...	...
Total	329	195	524	100.0	...
No. cases involved	315	158	315	...	...

TABLE IV: ACCURACY OF PNEUMOARTHROGRAMS IN RELATION TO MAJOR SURGICAL FINDINGS

Classification	April 1942–44			April 1944–45			Total		
	No. Cases	No. Major Findings	Per cent	No. Cases	No. Major Findings	Per cent	No. Cases	No. Major Findings	Per cent
A. Diagnosis definitely suggested	127	134	55.3	66	67	77.0	193	201	61.1
B. Diagnosis partially correct	22	23	9.5	3	4	4.6	25	27	8.2
TOTAL A + B	149	157	64.8	69	71	81.6	218	228	69.3
C. Unsatisfactory examinations	33	35	14.5	2	2	2.3	35	37	11.2
D. Mistaken diagnoses	48	50	20.7	14*	14*	16.1	62	64	19.4
TOTAL C + D	81	85	35.2	16	16	18.4	97	101	30.6
General Totals (A + B + C + D)	230	242	100.0	85	87	100.0	315	329	99.9

* Lesion diagnosed on wrong side in two cases, making really two more errors than indicated for this period.

per cent) and these would also fall into this latter category.

Single miscellaneous findings included: a synovioma; an obliterated suprapatellar bursa; and one case in which a questionable finding of an abnormally loose medial meniscus was noted.

It is interesting to note the following total incidence of lesions in the knee (without regard to whether they were considered major or lesser findings): abnormal fat pad, 30.8 per cent; loose bodies without osteochondritis, 2.5 per cent (considered major in all but one case); osteochondritis or chondrosis, 25.4 per cent; arthritis, 12.7 per cent; crucial ligament tears, 7.0 per cent; popliteal cysts, 15.2 per cent, as previously indicated. More than one pathologic significant change was thus found in 158 of the 315 cases, or approximately one-half (Table III).

General Accuracy of the Pneumoarthrograms in Relation to the Diagnosis of the Major Surgical Finding (Table IV): We have considered the first two-year interval as separate from the third year in order to gain some idea of the improvement achieved as the result of experience in interpretation and improvements in technic. The pneumoarthrograms have been divided

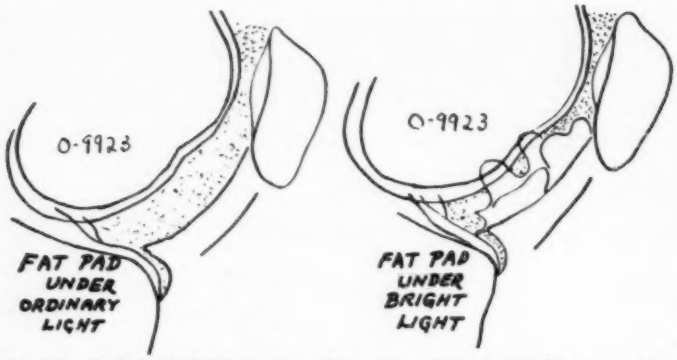


Fig. 26. Pathological infrapatellar fat pads. The lateral film must frequently be viewed under a bright light to reveal the lesion.

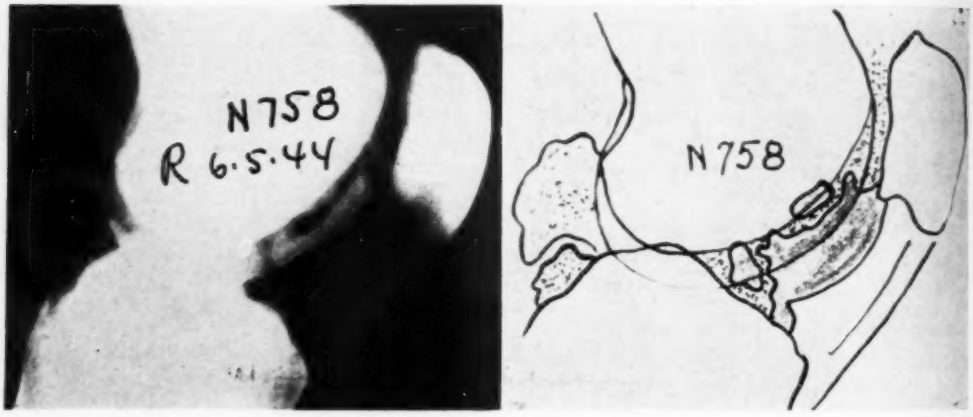


Fig. 27. Infrapatellar fat pad frayed with loose fragments.

into four groups: In Group A the correct diagnosis was definitely suggested; in Group B the diagnosis was partially correct; in Group C examination was unsatisfactory due to faulty technic either surgical or radiographic; in Group D an erroneous or misleading diagnosis was made. The classification is slightly different from that of McGaw and Weckesser in that any case in which the correct diagnosis was suggested was included in Group A, whether or not the statement was made in a positive manner; and any error, of commission or omission, was put in Group D.

In the first two-year interval, Group A comprised 55.3 per cent of the total, Group B, 9.5 per cent, Group C, 14.5 per cent, and Group D, 20.7 per cent. In the third year, Group A increased to 77 per cent, Group B diminished to 4.6 per cent, there was a marked diminution in Group C to 2.3 per cent, and Group D was reduced to 16.1 per cent. The reason for the marked diminution in Group C was not only an improvement in radiographic and surgical technic, but also a repetition of the entire examination when necessary, until a satisfactory result was obtained. Usually a second examination was sufficient if the first failed. In one or two cases a third examination was required. Technical improvements accounted to a great extent for the diminution in Groups B and C, many of these being transferred to Group A.

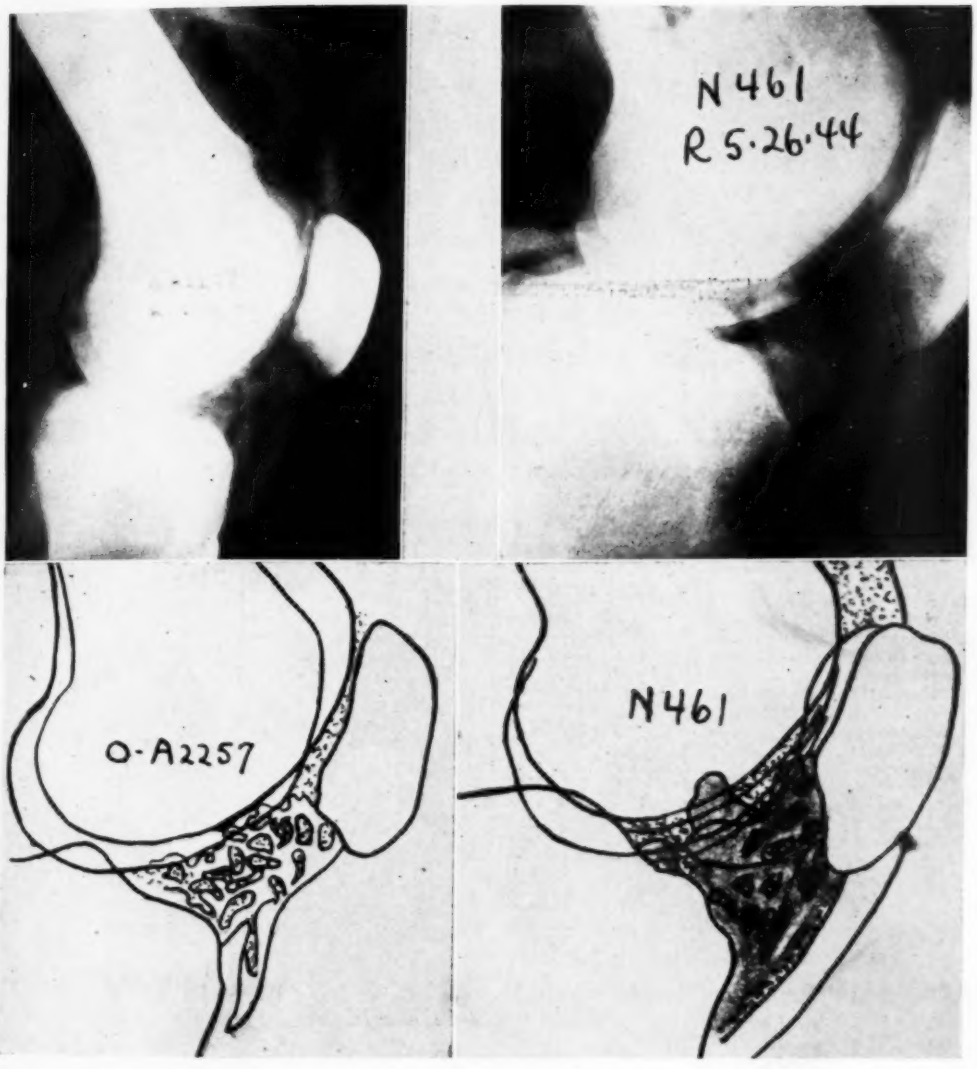


Fig. 28. Hypertrophied fat pads with numerous synovial tags.

The number of definitely misleading or erroneous diagnoses actually diminished relatively slightly. It will be noted from the analysis of errors below that these mistaken diagnoses fall to a great extent into a few groups, in which we have not as yet completely overcome the difficulties in arriving at an accurate diagnosis.

It is to be noted that in the third year the procedure was 81.6 per cent accurate. The over-all accuracy for the three-year period is not nearly so good: Group A, 61.1 per cent; Group B, 8.2 per cent; Group C, 11.2 per cent; Group D, 19.4 per cent.

Relative Accuracy of Clinical Examination Without Reference to Radiographic Studies (Table V): For analyzing the accuracy of the clinical diagnoses, the cases are divided into five groups: In Group A the findings were typical of internal derangement: injury with swelling,

TABLE V: ACCURACY OF CLINICAL EXAMINATION ALONE IN RELATION TO MAJOR SURGICAL FINDINGS

Classification	April 1942–44			April 1944–45			Total		
	No. Cases	No. Major Findings	Per Cent	No. Cases	No. Major Findings	Per Cent	No. Cases	No. Major Findings	Per Cent
A. Diagnosis definitely suggested	106	111	45.9	44	46	52.9	150	157	47.7
B. Diagnosis partially suggested	56	59	24.4	19	19	21.8	75	78	23.7
TOTAL A + B	162	170	70.3	63	65	74.7	225	235	71.4
C. Diagnosis not evident	13	16	6.6	3	3	3.4	16	19	5.8
D. Definitely misleading	34	35	14.5	12	12	13.8	46	47	14.3
TOTAL C + D	47	51	21.1	15	15	17.2	62	66	20.1
E. Data Poor	21	21	8.6	7	7	8.0	28	28	8.5
GENERAL TOTALS (A + B + C + D + E)	230	242	100.0	85	87	99.9	315	329	100.0

TABLE VI: ACCURACY OF COMBINED DATA (CLINICAL AND PNEUMOARTHROGRAPHIC)

Classification	April 1942–44			April 1944–45			Total		
	No. Cases	No. Major Findings	Per Cent	No. Cases	No. Major Findings	Per Cent	No. Cases	No. Major Findings	Per Cent
1. Diagnosis suggested by both	95	101	41.7	53	55	63.2	148	156	47.4
2. Both misleading or poor	14	15	6.2	6	6	6.9	20	21	6.4
3. Pneumoarthrograms accurate; clinical studies not	35	37	15.3	9	9	10.3	44	46	14.0
4. Clinical studies accurate, pneumoarthrograms not	65	68	28.1	10	10	11.5	75	78	23.7
5. Pneumoarthrograms accurate, clinical data inadequate	19	19	7.8	7	7	8.0	26	26	7.9
TOTAL: COMBINED DATA ACCURATE	214	225	92.9	79	81	93.0	293	306	93.0
6. Pneumoarthrograms misleading, clinical data inadequate	2	2	0.8	0	0	0.0	2	2	0.6
TOTAL	230	242	99.9	85	87	99.9	315	329	100.0

pain, localized tenderness over the joint, locking, catching or clicking of the joint, with much disability. In Group B the findings were fairly suggestive of internal derangement: there was no history of locking, catching, or clicking; otherwise the same as Group A. In Group C the findings were indefinite—swelling, pain, disability; in Group D the findings were misleading, and in Group E the clinical data were inadequate (8.5 per cent of the cases).

It is to be noted that an accurate diagnosis is usually not so readily made on clinical grounds alone, without radiographic assistance, and frequently is limited to "internal derangement."

The accuracy of the clinical examination alone is indicated by the following percentages: Group A, 47.7 per cent; Group B, 23.7 per cent; Group C, 5.8 per cent; Group D, 14.3 per cent. The total for Groups A and B was 71.4 per cent and for Groups C and D 20.1 per cent. This is exclusive of the 8.5 per cent for which the clinical data were inadequate. The percentages for the first two-year interval and the third year agree very closely.

Accuracy of Clinical Examination and Pneumoarthrogram Considered Together (Table VI): For this analysis, the cases are divided into the following groups: Group 1, in which both the clinical diag-

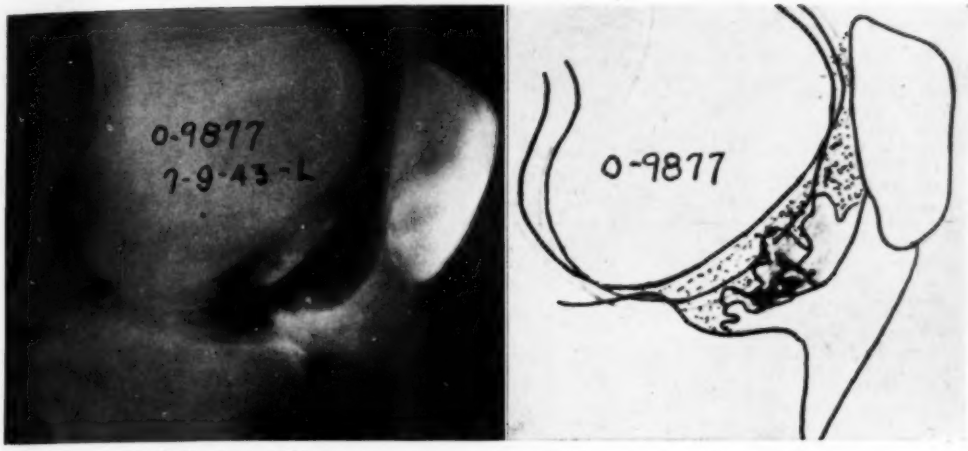


Fig. 29. Hypertrophied and hemorrhagic fat pads—filling up usually seen infrapatellar clear space.

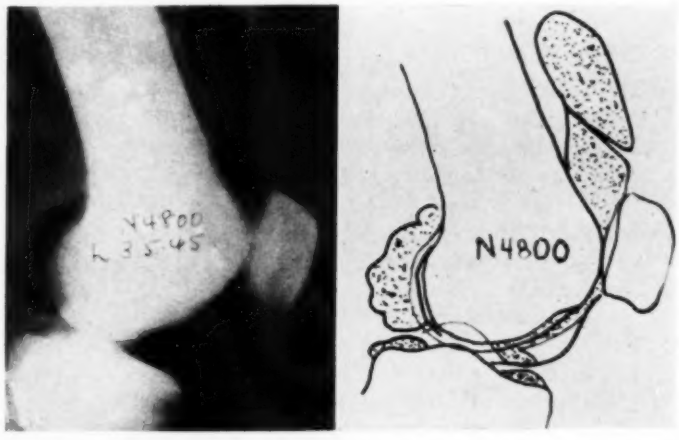


Fig. 30. Fat pad adherent to the tibial plateau.

nosis and the pneumoarthrograms were accurate; Group 2, in which both were inaccurate; Group 3, in which the pneumoarthrograms were entirely or partially correct while the clinical diagnosis was misleading; Group 4, in which the clinical diagnosis was accurate but the pneumoarthrograms were misleading or erroneous or unsatisfactory; Group 5, in which the pneumoarthrograms were either entirely or partially correct, but the clinical data were inadequate.

The pneumoarthrograms and the clinical diagnosis were equally accurate in 41.7 per cent of the cases seen in the first two-year interval, and 63.2 per cent in the third year, an over-all percentage of 47.4 per cent. The diagnoses were equally erroneous in 6.2 per cent during the first two years and 6.9 per cent in the third year, an over-all percentage of 6.4 per cent. The clinical diagnosis was accurate where the pneumoarthrograms were not in 28.1 per cent in the first two-year interval, and in 11.5 per cent in the third year, an over-all percentage of 23.7 per cent. The reverse was true (*i.e.*, the clinical diagnosis was inaccurate and the pneumoarthrograms accurate) in 15.3 per cent during the first two years, and 10.3 per cent in the third year, an over-all

TABLE VII: ANALYSIS OF ERRORS

Type of Error	Medial Meniscus	Lateral Meniscus	Total
Errors of commission	15	8	23
April 1942–44	(8)	(5)	..
April 1944–45	(7)	(3)	..
Errors of omission	33	10	43
April 1942–44	(30)	(7)	..
April 1944–45	(3)	(3)	..
TOTAL	48	18	66*

* Wrong side diagnosed in two cases.

TABLE VIII: MAJOR ERRORS

Type of Error	April 1942–44	April 1944–45	Total
Errors with osteochondritis	4	5	9
Anomalously short meniscus considered bucket-handle fracture	1	3	4
Tip fracture (cornua) not shown on films	15	0	15
Medial meniscus	(13)	..	..
Lateral meniscus	(2)	..	..
TOTAL	20	8	28

figure of 14 per cent. It is very significant that in the third year either the clinical diagnosis or the pneumoarthrogram was of value where the other was not in approximately an equal number of cases, and in addition, the pneumoarthrogram was of value in 8 per cent of the cases where clinical data were inadequate for analysis.

Analysis of Errors in Diagnosis (Tables VII and VIII): There were a total of 66 errors in 64 cases, the duplication occurring where the lesion was diagnosed on the wrong side, thus involving both an error of commission and omission. There were 23 errors of commission, 15 in the medial meniscus and 8 in the lateral. There was no significant difference in this group between errors made in the third year and in the first two-year period. There were 43 errors of omission, 33 involving the medial and 10 the lateral meniscus. In this case the difference between the first two-year interval and the third year is significant. There were 30 errors of omission with regard to the medial meniscus in the initial two-year period, whereas there were only 3 in the third.

In the third year there were 10 errors of commission, and 6 of omission, whereas in the first two-year period there were 13

Fig. 31. Obliterated suprapatellar bursa as the result of previous injury. Note the healed fractures of the patella.

errors of commission and 37 of omission. Considering these results in the light of 230 examinations in the first two-year interval as against 85 in the third year, there was an over-all improvement in accuracy in the third year, but the relative numbers of errors of commission actually increased in the third year. The great improvement came in avoiding errors of omission.

For the entire three-year period, 48 of the errors involved the medial meniscus, and 18 the lateral. This gives approximately the same ratio for errors as for the incidence of lesions at the two sites. In the first two years 38 errors involved the medial and 12 the lateral meniscus, whereas in the third year 10 involved the medial and 6 the lateral.

Approximately 23 per cent of all errors were due to cornu fractures of a meniscus which were not shown on the films. All of these errors were made in the first two-year period, and all but two of them were in relation to the medial meniscus. Approximately 14 per cent of all of the errors were in cases which also had osteochondritis of one type or another. It has been our experience that confusing air shadows are not infrequent in cases of osteochondritis dissecans. An anomalously short meniscus simulating the bucket-handle type of fracture caused four of the errors, but fortunately this is an unusual occurrence.

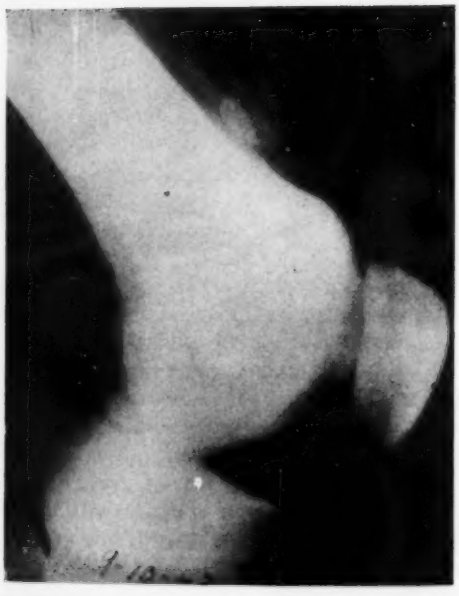


Fig. 32. Synovioma. The sharply demarcated tumor is seen projecting into the shadow of the suprapatellar bursa.

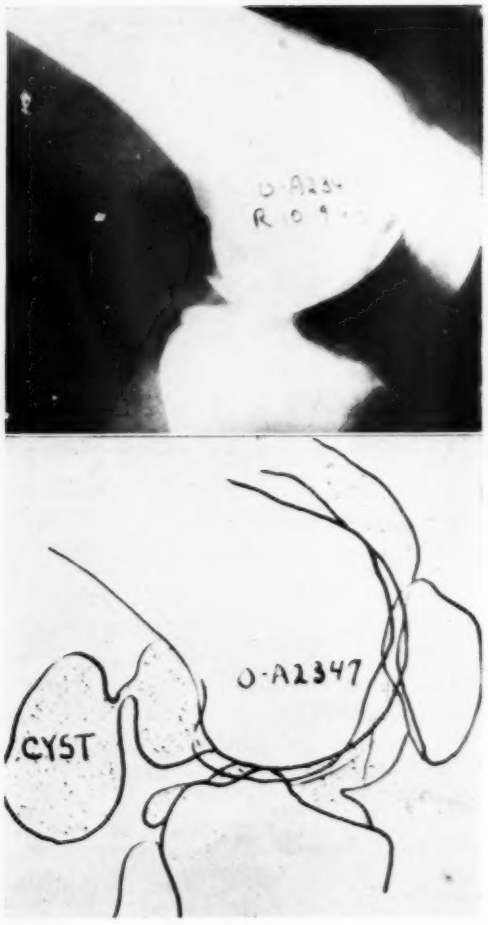


Fig. 33. Popliteal cyst (bursa). The communication between the posterior pouch and the cyst is well visualized.

GENERAL ANALYSIS OF STATISTICS

Abnormalities of the lateral meniscus and medial meniscus are found in a ratio of approximately 2 to 5 and together account for two-thirds of the major lesions in internal derangements of the knee joint.

An abnormal fat pad is found in somewhat less than one-third of the cases. In a few of these the fat pad was torn, or loose bits were free in the joint, or the pad was adherent to one of the cartilaginous structures. In these few cases abnormality of the fat pad can probably truly be called a major pathologic change. Otherwise, fat pad abnormalities are usually secondary to some other pathologic process in the joint.

About one-quarter of the patients had

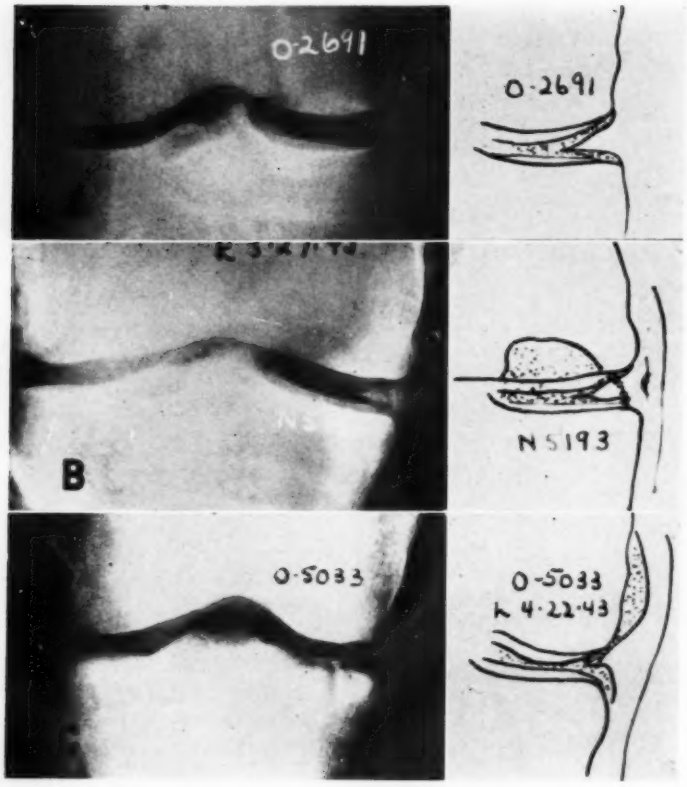


Fig. 34. Analysis of erroneous diagnoses. A. Fractured anterior or posterior cornua not indicated on the films. B. Osteochondritis dissecans with unusual extraneous shadows superimposed over the meniscus. C. Anomalously short meniscus, otherwise normal, simulating an absent meniscus, or dislocation tear of the meniscus (bucket-handle fracture).

either osteochondritis dissecans or chondrosis of the patella. This frequency is approximately one-half that of medial meniscus lesions, and 5 per cent greater than the incidence of abnormalities of the lateral meniscus. About one-quarter of the cases with osteochondritis or chondrosis also had loose bodies in the joint; in about one-half there were other major pathologic changes in the knee joint, such as a fractured meniscus. The relatively high incidence of chondrosis of the patella is noteworthy. Its frequency was almost equal to that of osteochondritis of the medial femoral condyle alone, and it was not infrequently associated with a loose body. Plain radiographs of the knee are probably just as valuable as pneumoarthrograms in the diagnosis of this abnormality.

Cornu fractures of a meniscus, especially the medial, are very difficult to diagnose and may escape detection. These accounted for approximately one-quarter of all our errors of the past three years. Many of the errors of omission of the first two-year interval have now been corrected with improved technic. Actually errors of commission are now the greater problem, whereas previously the reverse was true.

Our greatest improvement in diagnosis in the past three years has been in taking pneumoarthrographic studies out of the unsatisfactory group from a technical standpoint (Group C) and placing these in

a diagnostic group. The relative percentage of errors has diminished only from 20.7 to 16.1 per cent.

In its present stage of development, the pneumoarthrogram is approximately 80 per cent accurate. We believe that the clinical examination at best is approximately 70 per cent accurate. Thus *the pneumoarthrogram has achieved a greater accuracy than the clinical examination.* Moreover, in the case of the pneumoarthrogram, the type and completeness of the lesion can be more accurately predicted. This more complete information is especially valuable when both the medial and the lateral menisci are involved in the same knee. Both abnormalities can thereafter be corrected at the same time, a condition not very likely without the assistance of pneumoarthrography.

It is also highly significant that the pneumoarthrogram and clinical examination are frequently complementary and permit a greater accuracy when employed together. Frequently, the pneumoarthrogram is accurate where the clinical examination is not, and *vice versa*, so that *when one arrives at a diagnosis both clinically and radiographically, a very high degree of accuracy is achieved, probably in the neighborhood of 90 per cent.* As in all phases of diagnostic medicine, the clinical and the radiographic pictures must ultimately be viewed together in order to obtain the most accurate diagnosis.

SUMMARY

1. A technic for pneumoarthrography of the knee, employing a special device for spreading the knee joint, is described.

2. The normal pneumoarthrogram is discussed, and its various normal appearances are illustrated.

3. The abnormal pneumoarthrogram is discussed, and its various pathological appearances are illustrated.

4. The pneumoarthrogram is of special value in the diagnosis of abnormal menisci, fat pads, and bursae. These cases account for over two-thirds of the major lesions in internal derangements of the knee joint.

5. In other causes of internal derangement of the knee, the plain radiographs are usually of equal value for diagnosis. Oxygen contrast is not as a rule necessary for the diagnosis of osteochondritis dissecans or chondrosis of the patella.

6. Popliteal bursae are probably seldom of pathologic significance. They occurred in 13.5 per cent of the present series.

7. The pneumoarthrogram was found to be 81.6 per cent accurate. It is estimated that the clinical examination alone is about 70 per cent accurate, and frequently the exact nature of the lesion cannot be diagnosed. The pneumoarthrogram has thus proved its value as an excellent diagnostic measure. When the pneumoarthrogram and the clinical examination are considered together, it is found that they are equally good in 47.4 per cent of the cases, and supplement one another in 37.7 per cent of the cases. With their combined use, a 90 per cent accuracy can probably be achieved.

8. The errors made have been analyzed and compared for the first two years of this three-year study and the third year. In the third year the percentage of erroneous diagnoses diminished from 20.7 per cent to 16.1 per cent. The greatest improvement was made in reducing the unsatisfactory examinations and partially correct examinations from 24 per cent to 6.9 per cent, thus increasing the percentage of accurate diagnoses from 55.3 per cent to 77 per cent.

9. We have found pneumoarthrography of the knee joint to be without risk and now practice it routinely in all cases of suspected internal derangement.

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SUMARIO

Nueva Neumoartrografía de la Rodilla con su Valuación en 315 Casos

La técnica descrita utiliza para la neumogonartrografía un artefacto especial que distiende la rodilla. El tobillo y el muslo se colocan en fayas o abrazaderas, moviéndose el primero hacia un lado y luego hacia el medio en un bloque de madera colocado a lo largo del punto de origen lateral o medial de la articulación, lo cual ensancha el espacio articular del lado opuesto del bloque en turno para las distintas exposiciones. Cuando las películas corrientes en las posiciones dorsal y prona no facilitan una visualización suficientemente exacta de los meniscos, se voltea la rodilla para un lado u otro, dejando que se eleve el oxígeno inyectado, se extiende la rodilla sobre un bloque que sirve de punto de apoyo, y se asiesta el haz de rayos X horizontalmente a través de la articulación. Los grabados y diagramas adjuntos revelan los hallazgos normales y anormales en los varios tejidos de la rodilla.

Este procedimiento ha sido empleado en 315 casos operados subsiguientemente y en los que se basa la comunicación actual.

El neumoartrograma resultó de valor decidido en el diagnóstico de anomalías de los meniscos, acumulaciones de tejido adiposo y bolsas, que comprenden más de dos terceras partes de las grandes lesiones en los trastornos internos de la rodilla. En los debidos a otras causas, las películas corrientes suelen resultar de igual valor diagnóstico. Por regla general, no se necesita el contraste con oxígeno para el diagnóstico de la osteocondritis disecante o condrosis de la rótula. Pueden descubrirse también las bolsas poplíteas, pero probablemente rara vez poseen importancia patológica.

En la serie descrita, las neumoartrografías mostraron una exactitud aproximada de 80 por ciento, comparado con 70 por ciento para los estudios clínicos, aunque los últimos frecuentemente no revelaron la naturaleza exacta de la lesión. Las dos

clases de examen resultaron igualmente buenas en 47.4 por ciento de la serie y se complementaron mutuamente en 37.7 por ciento, en tanto que, combinadas, alcanzaron una exactitud de 90 por ciento.

El porcentaje de errores radiológicos en el diagnóstico bajó de 20.7 en los primeros dos años en este estudio trienal a 16.1 en el tercer año. El mayor adelanto consistió en rebajar la proporción de exámenes poco satisfactorios y parcialmente correctos de 24 por ciento a 6.9 por ciento, haciendo subir así el porcentaje de diagnósticos exactos de 55.3 a 77.

No se han observado complicaciones con el procedimiento, el cual parece inocuo.

Dissecting (Intramural) Pharyngo-Esophageal Diverticulum[1]

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A DISSECTING pharyngo-esophageal diverticulum has, to the best of our knowledge, never been reported in the literature. The roentgen signs of such a dissecting form of pulsion diverticulum are characteristic and permit of a preoperative diagnosis, once the pathological possibility of such a lesion is established.

The intramural pharyngo-esophageal diverticulum in the case to be recorded here was situated posteriorly between the mucosa and muscularis of the esophagus. The roentgen appearance and characteristics of such a lesion can quite readily be surmised. Although there are points of similarity between the intramural and extramural forms, one can easily differentiate one from the other. It is hoped that the description of our findings will lead to the discovery of more such forms of pharyngo-esophageal diverticulum before surgical extirpation is attempted. Our patient would have been spared some anxious and dangerous moments had the roentgen features been fully appreciated and a correct preoperative diagnosis been made.

CASE REPORT

R. K., a boy of 15, in September 1945 told his step-father, a physician, that he had been having difficulty in swallowing for about one month. He encountered more difficulty with solid foods than with semisolids or fluids. With the latter two, repeated swallowing would serve to relieve the discomfort, but meat and similar solids would "get caught" and it would be necessary to "cough them up" before relief was obtained. The patient noticed no swelling of the neck following the intake of food, fluid or solid. He had lost no weight.

For years the patient had been in the habit of swallowing his food after very little mastication. He had had mumps and measles during early childhood. His father died at the age of thirty-nine after a "heart attack." His mother is living and well, except for attacks of migraine headaches. There are no brothers or sisters.

The patient was tall and thin, 6 feet 2 inches in height and weighing approximately 165 lb. Examination of the head was essentially negative. The neck was extremely long but no swelling or lymphadenopathy was found. No abnormalities were discovered in the chest, abdomen, or extremities.

The blood Wassermann test was reported as negative. The red blood cell count was 5,100,000; the white blood cell count 8,200, with a normal differential count. The sedimentation rate was normal and urinalysis disclosed no abnormalities.

Roentgen examination of the upper gastro-intestinal tract with the aid of a barium meal on Sept. 29, 1945, disclosed a diverticulum in the lower cervical region. No obstruction or dilatation was observed. The diverticulum arose at about the level of the 6th or 7th cervical vertebra, was situated posteriorly, and could not be separated from the esophagus proper at any time during examination. After the ingestion of approximately half a glass of barium mixture, the diverticulum attained a size of approximately 2 × 5 cm. (Fig. 1). A sphincter-like configuration of the diverticular neck was observed (arrow). There was a peculiar "lifting" of the diverticulum when the patient was asked to swallow without further administration of the barium sulfate mixture, and with every such swallow, whether he was in the upright or recumbent position, the diverticulum diminished in size. After several such "blank" swallows it measured no more than 1.5 cm. in diameter (Fig. 2). The diverticulum was "lost" in the lateral view (Fig. 3). A close relationship between the barium-filled esophagus and diverticulum was maintained in the anteroposterior and oblique positions, but in the lateral view the diverticulum seemed to disappear. The roentgen diagnosis was pharyngo-esophageal diverticulum, but the unusual features described above could not be accounted for satisfactorily. It was thought possible that the diverticulum was situated slightly to one side of the mid-line and, therefore, overlapped the opacified esophagus in the lateral view. The "contraction" phenomenon was, to say the least, puzzling. The only explanation offered was that the capacity of the diverticulum might have been limited by the close approximation of the cervical structures in the boy's long narrow neck.

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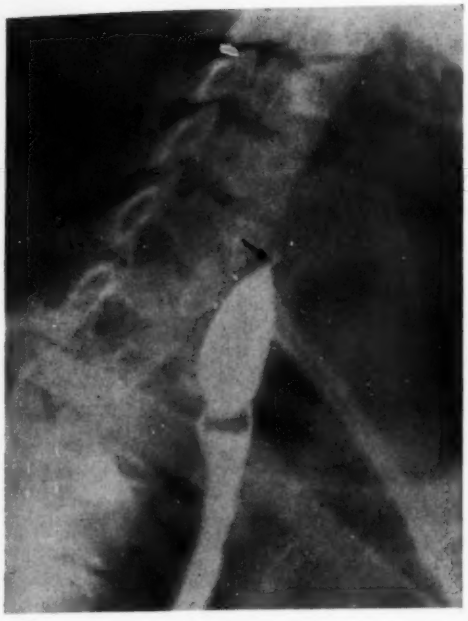

Fig. 1. Right anterior oblique projection of pharyngo-esophageal diverticulum opacified immediately after swallowing 4 ounces of a barium mixture. The diverticulum never attained a size larger than 2 × 5 cm. Note sphincter-like outline (arrow) at the origin of the diverticulum.

The patient was taken to the Mayo Clinic, where the diagnosis of pharyngo-esophageal diverticulum was confirmed and surgery was performed on June 13, 1946. The surgical findings and pathological findings as submitted by Dr. Howard K. Gray are as follows:

"Exposure through an incision which was made along the posterior border of the sternocleidomastoid on the left revealed a very deeply situated esophagus. There was almost complete mobilization of the esophagus well into the mediastinum and there was no evidence of an extra-esophageal diverticulum. A longitudinal incision was made in the left lateral wall of the esophagus approximately 6–7 cm. in length, and on the posterior wall of the esophagus just opposite the cricoid level was an esophageal pouch which emptied readily, admitting the index finger and extending for approximately 2.5 to 3 cm. posteriorly under the muscularis. This mucosal pouch was turned inside out and excised, suturing the base of the pouch with one continuous suture of silk. The longitudinal opening in the esophagus was then closed with multiple interrupted sutures of silk and reinforced by attempts to patch over this area the remaining portion of the muscularis. In order to obtain exposure, the sternocleidomastoid muscle was cut in its mid portion and, in closing, the two ends of this muscle were brought together with multiple interrupted mattress sutures of chromic catgut. Two Penrose drains were left in the wound, one down into the mediastinum and one up to the margin of the opening in the esophagus. A Rehfuss tube was placed in the stomach at the time of the operation and should be left in place for at least a week.

"The pathologists reported a pharyngo-esophageal diverticulum."

Course: Following surgery, several serious complications arose. A marked degree of tracheal obstruction, due to edema, developed secondary to the extensive resection. An emergency tracheotomy was performed one day following the operation. Soon afterward collapse of the right lung occurred. Thereafter, with active symptomatic treatment the patient made an uneventful recovery.

Fig. 2. Reduction in size of diverticulum after "blank" swallowing, patient still in upright position.

Follow-up Record: Postoperative roentgen examination of the esophagus at the Mayo Clinic revealed no abnormality in the pharyngo-esophageal area, and the patient was dismissed approximately five and a half weeks following admission. Before his discharge plastic repair of the cervical and tracheotomy wounds was performed. Keloid formation in the operative and tracheotomy scars was subjected to superficial x-ray therapy with excellent results.

COMMENT

Diverticula of the esophagus are usually described as either of pulsion or traction

Fig. 3. Lateral projection of barium-filled esophagus and diverticulum during the act of swallowing. Note superimposition of the opacified diverticulum and esophagus proper. The piriform shadow of greater density (outlined by arrows) represents the filled intramural diverticulum.

type, but Templeton (5) considers a third class, namely, functional diverticula. On the basis of our experience, we have subdivided the pharyngo-esophageal pulsion diverticula into two categories: (1) intramural or dissecting; (2) extramural or extra-esophageal. The classification is as follows:

I. Functional diverticula.
II. Traction diverticula.
III. Pulsion diverticula.
  A. Pharyngo-esophageal.
    1. Extra-esophageal or extramural.
    2. Dissecting or intramural.
  B. Supradiaphragmatic or "epiphrenial."

It is beyond the scope of this paper to consider in detail the pulsion and traction types of esophageal diverticula. They are discussed by many authors, including Kulvin (1), Lahey (2), Melamed and Zimmerman (3), Pancoast *et al.* (4), and Templeton (5). It will suffice to recall a few established facts as to pharyngo-esophageal diverticula. These diverticula arise at about the level of the 6th cervical vertebra below the level of the cricoid cartilage. The outer muscular layer of the esophagus consists of longitudinal fibers, while the inner layer is comprised of circular fibers. Herniation of pharyngo-esophageal diverticula ordinarily occurs through a V-shaped gap posteriorly, where the longitudinal fibers divide at the cephalad end of the esophagus. These diverticula, for unexplained reasons, are seen most frequently on the left side (1, 4).

Pharyngo-esophageal diverticula occur chiefly in middle-aged persons, and symptoms have usually been present for many years before medical advice is sought. Our patient was unusually young, probably one of the youngest on record. The etiology of the dissecting form of pharyngo-esophageal diverticulum which he displayed has not been ascertained, but the evidence seems to point to a developmental abnormality. Probably a sac or fold was present from birth and was slowly enlarged and/or opened when traumatized by unusually large boluses of food. From the time of onset of symptoms to the time of surgery—a period of ten months—the symptoms were identical and did not increase in severity. Nor was there any appreciable change in the size and shape of the diverticulum during the interval between roentgen examinations—approximately nine months. At the time of surgery it was impossible to demonstrate any thinning of the wall of the diverticulum at any one point.

Previous mention in this paper has been made of the tendency of the diverticulum to empty after repeated "blank" swallowing. The reason for this is quite evident when one realizes that the sac lay entirely inside the muscular layer. It is purely conjectural to envisage what might have occurred had the patient been allowed to go untreated for a number of years. Would the diverticulum have remained stationary in size? Would it have increased in size by dissecting further between the mucosal and muscular layers, or would it eventually

have herniated through the muscular wall posteriorly and assumed the usual appearance of a pharyngo-esophageal diverticulum? Does the dissecting type of diverticulum represent an "aborted" form of the ordinary pharyngo-esophageal diverticulum, the momentarily weakened muscular wall having regained its integrity, forcing the sac down between the mucosa and muscularis instead of leading to posterior herniation? These questions are left unanswered pending the discovery of more such cases, more pertinent etiological facts, common denominators, etc.

The requirements and details of complete roentgen examination of the esophagus have been reviewed by Templeton (5), Melamed and Zimmerman (3), and others. In our case the roentgen signs were identical whether the patient was examined in the upright or recumbent position. In the light of the established pathology and conception of pharyngo-esophageal diverticula, the observation of emptying of the diverticulum with the patient upright was most disturbing and incomprehensible. The contraction of the esophagus around the diverticulum actually expressed the contents of the sac, thereby reducing the size of the diverticulum. The diverticulum appeared to rise or be "lifted" during deglutition due to evacuation, the contracting esophagus expelling the contents of the intramural sac. The extramural type contains no muscular tissue, is incapable of contraction, and empties only when the patient is placed in a position in which the fundus of the diverticulum is brought above the level of the diverticular neck. Such extra-esophageal diverticula become distended while the patient is in the upright position and are usually larger than the one in our patient. The extramural form usually occurs on the left side (1, 4). The intramural diverticulum in our patient occurred in the mid-line posteriorly, and a sphincter-like configuration of the diverticular neck (Fig. 1) was noted. In retrospect, on close inspection of the lateral projection, a piriform shadow of relatively greater density (arrows) than the barium-filled esophagus proper can be found. Very close scrutiny of the lateral projection is mandatory in every case of pharyngo-esophageal diverticulum.

SUMMARY

A dissecting form of pharyngo-esophageal diverticulum is described in a 15-year-old boy. Symptoms were present for only one month prior to the first roentgen examination and surgical extirpation was performed nine months later.

The roentgen signs of the intramural pharyngo-esophageal diverticulum in this patient were as follows: (1) opacification and emptying of the diverticulum during examination in the upright position; (2) an apparent elevation or "lifting" of the diverticulum during deglutition, due to expulsion of its contents by the surrounding and contracting esophageal musculature; (3) origin in the mid-line posteriorly; (4) obscuration or "disappearance" of the opacified diverticulum in the lateral view, due to superimposition of the opaque shadows of the diverticulum and esophagus proper.

If all dissecting pharyngo-esophageal diverticula occur in the mid-line posteriorly, one can easily appreciate the indispensability of the lateral view of the opacified esophagus and diverticulum in order to reveal the location of the pouch. Close scrutiny and careful analysis of the relative densities on the lateral esophagram are necessary if one is to determine the true nature of the diverticulum—either intramural or extramural.

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SUMARIO

Divertículo Faringo-Esofágico Disecante Intramural

Descríbese un divertículo faringo-esofágico disecante en un niño de 15 años. Sólo había habido síntomas desde un mes antes del primer examen roentgenológico y la extirpación quirúrgica se realizó nueve meses después.

En este paciente los signos radiológicos fueron los siguientes: (1) opacidad y vaciamiento del divertículo durante la deglución; (2) "elevación" del diafragma durante la deglución con disminución de tamaño del divertículo después de contraerse el esófago alrededor del saco; (3) origen detrás de la línea media; (4) oscurecimiento o "desaparición" del divertículo "opacificado" en la vista lateral, debido a la sobreposición de las sombras opacas del divertículo y el esófago mismo.

Si todos los divertículos faringo-esofágicos disecantes se presentan detrás de la línea media, es fácil apreciar cuán indispensable es la vista lateral del esófago y el divertículo oscurecidos para revelar la localización de la bolsa. Para determinar la verdadera naturaleza—ya intra- o extramural—del divertículo hay que escudriñar y analizar con cuidado las densidades relativas en el esofagrama lateral.

Spinal Extradural Hemangioblastoma Roentgenographically Visualized with Diodrast at Operation and Successfully Removed[1]

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EXTRADURAL hemangioblastomas of the spine appear to be relatively uncommon. Four instances of intraspinal hemangioblastoma were recorded by Elsberg (1) in a series of 253 intraspinal tumors, and but one of these was extradural. So-called hemangiomas of the vertebrae resulting in cord compression are more common. In 1943 Blackford (2) collected 65 such cases from the literature, including one of his own. On the basis of his microscopic description of the tumor, Blackford's case, and probably some of the others as well, were most likely hemangioblastomas, that is, true neoplasms composed of growing angioblasts rather than hemangiomas (angiomas), which are vascular malformations. This distinction has been clearly made by Cushing and Bailey (3), although considerable confusion of terminology still exists with respect to these lesions.

It is the purpose of this communication to relate an experience which, so far as is known to the writer, is unique. A pulsating hemangioblastoma arising from the spinal extradural space was encountered. At the time of the first operation the extent and the true nature of the lesion were not apparent, and it was considered inoperable. At a second operation, diodrast was injected into the mass and its extent as well as its main vessels of supply and drainage were clearly portrayed. It was then possible to extirpate the tumor and bring about functional recovery.

CASE REPORT

History: H. N., a 42-year-old male, entered the Hospital June 15, 1946, complaining of numbness and coldness of the feet as well as weakness of the lower extremities of fifteen years' duration; urgency and frequency of urination with diminution of sexual potency for two years; occasional low back pain with radiation down the entire left lower limb. The symptoms were progressive.

Examination: The general physical examination revealed a hard, freely movable mass, unattached to the skin, measuring 3.5 × 5.0 cm., located in the right anterior superior cervical triangle. The mass had first been noticed three years earlier and had increased in size gradually. A similar mass excised from the left cervical region sixteen years previously was diagnosed "tuberculous adenitis" on microscopic examination. The only other abnormal finding on general examination was the presence of hypertension (240/150). Neurological examination revealed the following abnormal findings: moderate weakness of both lower limbs, greater on the left; very active knee and ankle jerks with bilateral ankle clonus, absence of cremasteric reflexes, and bilateral extensor plantar responses; impairment in appreciation of pin-prick, hot and cold objects, and cotton-wool below the level of the groin on both sides, with a slight degree of sacral sparing of sensation; absence of appreciation of position sense of the great toes and vibration at the ankles.

X-ray examination of the thoracolumbar spine revealed a destructive process involving the pedicles and laminae of the eleventh and twelfth vertebrae on the left side (Fig. 1). There was also a spotty increase of density involving the posterior aspect of the body of the eleventh thoracic vertebra. Lumbar puncture with manometric study (Grant-Cone method of graduated jugular compression with a blood-pressure cuff) revealed evidence of a complete subarachnoid spinal block. The cerebrospinal fluid contained no cells and showed a negative Pandy reaction; the total protein content had not been determined. The Wassermann reaction of the cerebrospinal fluid was negative and the colloidal gold curve was normal. It seemed quite clear that the patient was suffering from a tumor involving the eleventh and twelfth thoracic vertebrae with compression of the spinal cord.

Further diagnostic studies were unnecessary but, due to a misunderstanding, fluoroscopic examination

[1] From the Neurosurgical Service of the Jewish Hospital of Brooklyn, New York. Accepted for publication in January 1947.

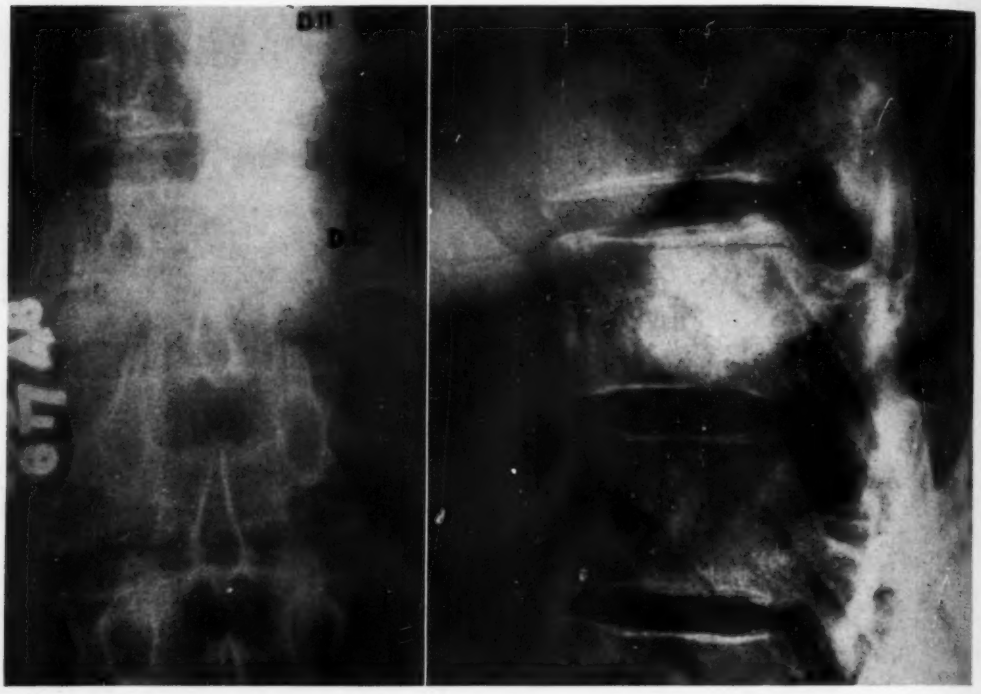

Fig. 1. A (left). Roentgenogram showing obliteration of pedicles of D11 and D12 on the left side. B (right). Lateral view showing obscuration of posterior margins of the body of D11 and possibly of D12, with alteration in the density of the vertebrae.

following the intraspinal (L5-S1) injection of 3 c.c. of pantopaque was done. Evidence of a spinal block at the upper border of the first lumbar vertebra was revealed. The pantopaque was removed immediately upon completion of the examination.

Operation: Under general anesthesia a laminectomy (T11 and T12) was done on June 18, 1946. A large, smooth, reddish mass, which pulsated vigorously, was found underlying the excised laminae and compressing the spinal cord severely (Fig. 2A). Aspiration yielded blood and upon withdrawal of the needle there occurred brisk bleeding which, however, was readily controlled by a piece of crushed muscle. It was my impression that the mass represented a large aneurysm, and attempt at its removal was considered hazardous, particularly in view of the marked degree of hypertension that existed. The wound was closed and it was hoped that some benefit would result from the decompression of the lesion.

Postoperative Course: Steady loss of all function of the lower limbs occurred together with urinary retention, so that nine days after operation only very feeble movement of the limbs was possible and there was practically complete loss of all forms of sensory appreciation below the level of the twelfth thoracic dermatome bilaterally. In view of the downhill course, it was decided to re-explore the lesion and attempt to visualize its extent by the use of diodrast as a prelude to possible removal.

Second Operation: On June 27, 1946, the laminectomy wound was re-explored. The pulsatile mass was exposed and preparations were made for the injection of a 35 per cent solution of diodrast. A 20-gauge needle was introduced into the mass and bright red blood was aspirated, following which a total of 5 c.c. of diodrast was injected. After 3 c.c. of the solution had been introduced, postero-anterior films of the spine were obtained, with portable apparatus with Bucky diaphragm (Fig. 3, A). A second injection of 5 c.c. of diodrast was carried out while lateral views were taken with the use of the Lysholm grid (Fig. 3, B). Cassettes with fast screens were used. One-second exposures were made, at 15 ma., 60 kv., with a target-film distance of 25 inches. Moderate resistance to the injection of the diodrast was encountered on each occasion.

The films obtained following the injection of diodrast into the mass clearly outlined the lesion and revealed a large blood vessel at its upper pole. It was still my impression that we were dealing with an aneurysm and preparations for an attempt at its removal were made. The left lateral wall of the vertebral canal at the level of D11 and D12 was removed by means of chisel and mallet, and the large

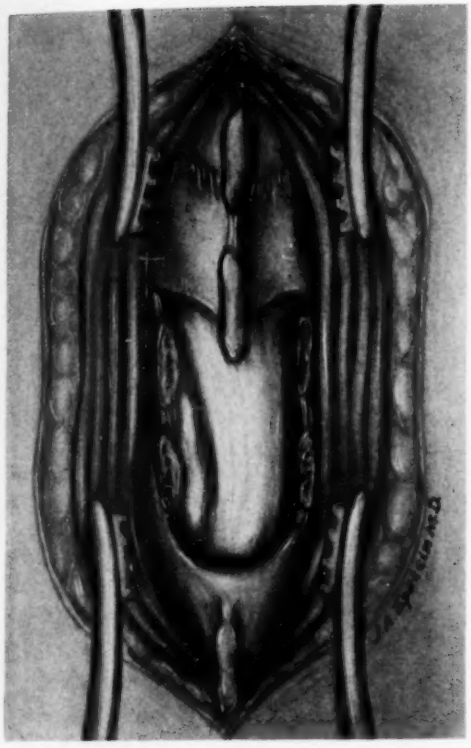

Fig. 2A. Drawing showing compression of spinal cord by the tumor which partially underlay it.

vessels entering its superior pole were doubly ligated and severed between silver clips, following which pulsation of the mass ceased. The superior pole of the tumor was freed and the mesial aspect was then readily separated from the dura, to which it was only slightly adherent. The encapsulated mass was found to be quite adherent on its undersurface to the body of the eleventh thoracic vertebra. After their separation the body presented a raw porous bleeding surface (Fig. 2B) and the contiguous surface of the tumor was ragged, suggesting extension of the tumor into the body of the vertebra as indicated by the roentgenogram. Several large vessels, in aggregate about 3 mm. in diameter and approximately equal in caliber to the superior polar vessels, were clipped and cut as they entered the mass at its lower pole. The bleeding from the posterior surface of the body of D11 was controlled with bone-wax. The wound was closed. The patient received a transfusion of 500 c.c. of blood on the operating table and his condition remained good throughout the procedure.

Subsequent Course: The patient showed a striking degree of improvement following removal of the tumor. He received a course of deep roentgen therapy to the operative site, totaling 1,800 r. Nineteen days after the tumor was extirpated, power in the lower limbs was normal except for impairment in strength at the left knee, approximating 20 per cent. Bilateral ankle clonus and extensor plantar responses, however, persisted and the cremasteric reflexes remained absent. Sensation was normal

Fig. 2B. Drawing showing tumor in the process of removal. The superior vessels have been clipped and the vessels at the lower pole are shown. The porosity of the underlying bone, into which the tumor extended, can be seen.

except for pin-prick and cotton wool appreciation over the anterior aspects of the thighs, which was said to be "nearly but not quite normal."

When the patient was seen on Aug. 20, two months after operation, he had full motor power of the lower limbs and the gait was normal. Bilateral ankle clonus and extensor plantar responses still persisted. Sensation was still "not quite normal" over the anterior aspects of the thighs.

Pathologic Examination: The tumor measured 3.4 × 1.7 × 9.0 cm. It was moderately soft. The external surface was pink and smooth except for the

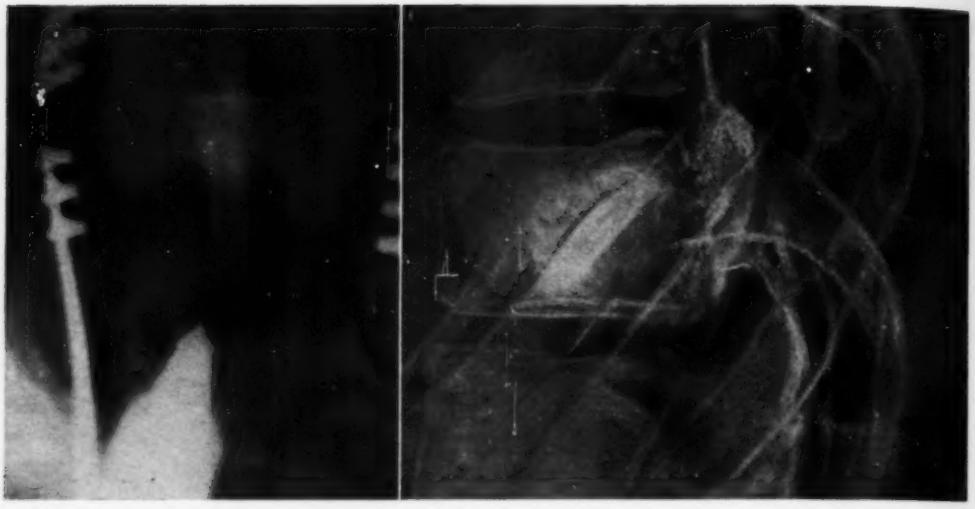

Fig. 3. A (left). Roentgenogram showing the outline of the tumor after the injection of diodrast. B (right). Sketch of lateral roentgenogram made following diodrast injection into the tumor. The outline of the tumor, as well as the blood vessels at its upper and lower poles, is shown. The original film was unfortunately lost.

site of attachment to the body of the eleventh thoracic vertebra. The cut surface (Fig. 4) was red and rather spongy, and several large blood vessels coursed through it.

The tumor was quite cellular, and its predominant feature was the presence of endothelial-lined channels, many of which contained erythrocytes. Some fully formed blood vessels with thick walls were seen, but most of the vessels were of the capillary and sinusoidal types (Fig. 5). The cells lining the blood spaces varied from flat, elongated cells to large cuboidal or polygonal cells containing vesicular nuclei. These latter cells were identical with the type cell of the tumor. Many of the tumor cells, however, contained nuclei of bizarre shape and some were multinucleated. Mitotic figures were not encountered. Some of the cells were vacuolated and resembled the so-called pseudo-xanthoma cells; also some hemosiderin-laden phagocytes were seen. In some areas there were invaginations of groups of large cells into the endothelial-lined canals. In part these heaped-up cells within the vessels possessed an endothelial cover; in addition, many large cells were present singly or in groups within the vessel lumen. Throughout the tumor there was an abundant network of reticulin fibers which clearly outlined the numerous blood channels and merged with the abundant dense collagenous framework. The base of the tumor at its zone of attachment to bone presented interdigitations of tumor cells and bone trabeculae.

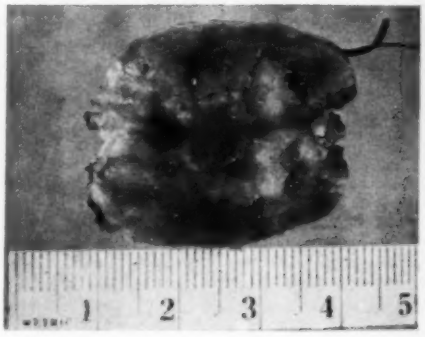

Fig. 4. Cut surface of the tumor.

DISCUSSION

The hazards of attempting to remove spinal hemangioblastomas at operation have been stressed by various authors. Blackford writes: "Certainly surgery should not be attempted until roentgen therapy has failed or until paraplegia has developed." His attitude is the result of the high operative mortality associated with attempts at removal of these lesions (severe hemorrhage was frequent) and the fact that in 12 cases "cure" has been reported following the use of x-rays. Blackford's own patient, an 18-year-old boy, was given roentgen therapy following biopsy and was in good health when last examined fourteen years after the onset of symptoms. The cases collected by Blackford form a heterogeneous group, including both vascu-

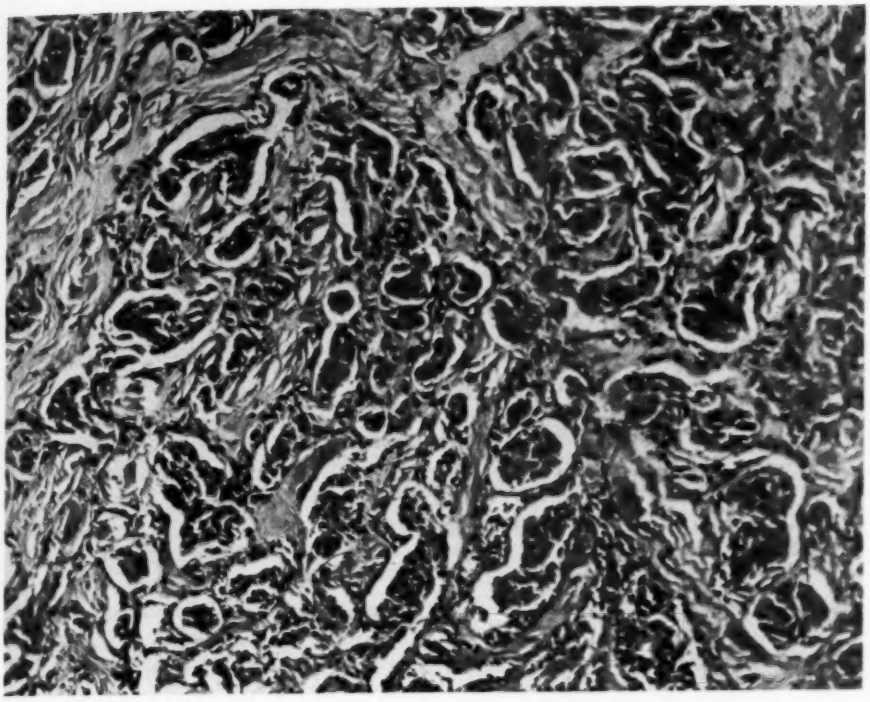

Fig. 5. Photomicrograph of tumor showing numerous endothelial-lined channels, with invagination of tumor cells into the lumina of vessels. Hematoxylin and eosin. ×150.

lar anomalies and neoplasms. It would be of interest to attempt a correlation of the precise histologic nature of the lesion with the clinical course following roentgen therapy, but the available data are insufficient for such a study.

Roentgen visualization of hemangioblastomas and angiomas after diodrast injection at operation would appear to render their removal safer. In this way the extent of the lesion together with the entering arteries and veins of exit might be readily determined. This was possible in the present case, in which the chief vascular supply of the tumor was interrupted as the initial step in its removal, with the result that very little bleeding occurred thereafter. Blackford's wait-and-see policy appears unwise in cases where symptoms of marked spinal cord compression exist, since the hazard of irreversible spinal cord changes is too great.

The x-ray changes of the vertebrae in the presence of hemangioma are considered to be characteristic, consisting in a sponge-like appearance or, more commonly, vertical striations, the result of thinning of the trabeculae of bone by the dilated cavernous spaces (4). This vertical striation was described in the case of Bailey and Bucy (5), which was successfully operated upon. The roentgen appearance of the hemangioblastoma in our case was unlike that seen in hemangioma, indicating, possibly, that these lesions may be differentiated radiographically.

The fact that the tumor reported here arose extradurally does not support the view of Globus (6) that hemangioblastomas ("pial (vascular) meningiomas of the hemangio-endotheliomatous type") arise from the pia mater. Nor does a leptomeningeal origin, as assumed for hemangioblastomas by Bailey, Cushing and Eisenhardt (7) and by Bailey and Bucy (8), seem likely, since the tumor was un-

attached to leptomeninges or dura mater. Many of these tumors bear a close resemblance to those described by general pathologists as hemangio-endotheliomas which arise from vascular endothelium anywhere in the body. Evidence of hemopoiesis within the tumor, such as has been reported in some cases of hemangioblastoma (3), was not seen in our case. The failure to demonstrate hemopoiesis in this tumor would seem to justify considering it as a hemangio-endothelioma. However, as Cushing and Bailey state, "this may be because of the difficulty of identifying such elements in ordinary microscopic preparations. We have unfortunately neglected to examine smears of fresh blood taken from these lesions at the time of operation." Evidence of blood cell formation in the tumor tissue alone would justify retention of the term hemangioblastoma rather than hemangio-endothelioma, which implies the formation of blood vessels rather than circulating blood elements from the tumor.

That the spaces within the tumor communicated with the general circulation is indicated by the fact that the diodrast was not visualized radiographically within the tumor after its removal at operation, the radiopaque material having entered the general circulation. It is likely that the frequent differences encountered between hemangioblastomas arising from the central nervous system and the hemangio-endotheliomas that arise elsewhere are attributable to environmental influences upon the tumor cells rather than significant differences in the cells of origin. In fact, many histological gradations between these various types of lesions occur.

SUMMARY

A case is reported in which the injection of diodrast at operation into an extradural spinal mass, at first thought to be an aneurysm, afforded its roentgenographic visualization. As a result of the clear demonstration of the extent of the lesion, together with its entering arteries and veins of exit, it was possible to remove the mass surgically with but little bleeding. The tumor proved to be a hemangioblastoma. Following its removal there were complete return of motor power, previously impaired, and almost complete return of sensibility. It is concluded that this technic may prove useful in outlining the limits of some vascular lesions, including aneurysms of the brain and spinal cord, when encountered at the operating table. The extent of these lesions is not always apparent from their superficial appearance. Their visualization, with demonstration of their vascular supply by radiography with contrast dyes injected at operation, may aid in the decision as to whether surgical excision can be undertaken and facilitate their removal.

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SUMARIO

Visualización con Diodrasto de un Hemangioblastoma Raquídeo Extradural

Comunícase un caso en el que la inyección de diodrasto al operar en una tumefación raquídea extradural, tomada al principio por un aneurisma, permitió la visualización roentgenográfica. Gracias a la clara demostración de la extensión del tumor, así como de sus arterias de entrada y venas de salida, resultó posible extirparlo quirúrgicamente con muy poca hemorragia. La neoplasia resultó ser un hemangioblastoma. Después de excindirlo, se recuperó completamente la facultad motriz, anteriormente afectada, y casi completamente la sensibilidad. Dedúcese que esta técnica puede resultar útil para delimitar los contornos de algunas lesiones vasculares, incluso aneurismas del cerebro y médula espinal, al dar con ellas en la mesa de operaciones, pues no se puede juzgar siempre la extensión de las mismas por su apariencia superficial. Su visualización, junto con la de su riego vascular, por medio de la radiografía con colorantes de contraste inyectados al operar, puede ayudar a decidir si la excisión resulta factible y facilitar la extirpación.

Further Studies on the Relation Between Radiation Effects, Cell Viability, and Induced Resistance to Malignant Growth

IV. Comparison of Effects of Roentgen Rays on Mammary Tumors Autogenous to Inbred Strains of Mice (dba and C3H)[1]

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PREVIOUS PUBLICATIONS (1, 2, 3, 4) have reported the effects of x-radiation experimentally determined on tumor cells *in vitro* and *in vivo*. Some of the results which emerged from these studies may be summarized briefly as follows:

SUMMARY OF RESULTS WITH MOUSE SARCOMA 180

Dosage Applied to Implants in vitro	*Effects of Irradiation*
Up to 3000 r/air	Implants produced tumors in the hosts
From 3,500 to 4,000 r/air	Implants produced no tumors but rendered the animals immune to subsequent viable implants of sarcoma 180
From 5,000 to 60,000 r/air (60,000 r equal to lethal dose for tumor fragments grown in a culture medium *in vitro*)	Implants produced neither tumor nor immunity, *i.e.*, the immunizing properties of the tumor grafts were destroyed

It was thus demonstrated that, in order to induce a resistant state in the experimental animal, *i.e.*, immunity to subsequent viable tumor grafts, the tumor implants had to be attenuated, but not destroyed, by a relatively specific dose of radiation.

The question arose whether or not this conclusion applies as well to tumors of known genetic origin grown in inbred strains of animals. Such a condition would correspond to the use of spontaneous tumors. Accordingly, in further experiments, an inbred strain of rats and a tumor which originated in the same strain were used. The results obtained are summarized as follows:

SUMMARY OF RESULTS WITH A RETICULUM-CELL LYMPHOSARCOMA AUTOGENOUS TO THE STRAIN

Dosage Applied to Implants in vitro	*Effects of Irradiation*
Up to 2000 r/air	Implants produced tumors
From 2,200 to 2,600 r/air	Implants produced no tumors but rendered about 65 per cent of the animals immune to subsequent viable implants
From 2,800 r/air up	Implants produced neither tumor nor resistance, *i.e.*, the immunizing properties of the tumor grafts were destroyed

Further experiments are planned to investigate a variety of tumors grown in inbred strains of animals as to their immunizing ability after attenuation with specific doses of radiation. Such a study may serve as a basis of classification of tumors into those with and without ability to induce a state of resistance to malignant growth.

The present report has to do with the determination of the radiosensitivity of the same type of tumor originating spontaneously in two different inbred strains of animals.

METHOD AND MATERIAL

Two inbred strains of mice, dba and C3H, and tumors originating in these strains were used in these experiments. Mice of the dba strain were obtained from the Roscoe B. Jackson Laboratory, Bar Harbor, Maine. This strain has been inbred since 1918. In 1920, a tumor arose

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[1] From the Cancer Research Laboratory, Department of Hospitals, and Laboratory of Cellular Physiology, New York University, New York.

Presented at the Thirty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–6, 1946. These experiments were aided by grants obtained from the Ella Sachs Plotz Foundation for Scientific Investigations and from Mr. J. C. Brownstone.

TABLE I: TUMORS PRODUCED BY NON-IRRADIATED CONTROL IMPLANTS IN dba STRAIN OF MICE

Experiment Number	Latent Period (days)	Average Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumors (mm.)	Remarks
1	6	4 × 3 × 2	12	24 × 19 × 10	Each experiment included 8 to 10 mice. Therefore the sizes recorded in this table represent averages of 8 or 10 tumors. The tumors were measured in three dimensions. The mice were killed when the tumors started to break through the skin.
2	6	5 × 4 × 2	14	27 × 21 × 12	
3	7	6 × 4 × 3	13	28 × 19 × 12	
4	5	3 × 2 × 2	14	31 × 16 × 16	
5	6	4 × 3 × 3	12	28 × 15 × 10	
6	6	4 × 3 × 2	13	30 × 15 × 12	
7	7	5 × 3 × 3	12	27 × 17 × 12	
8	8	6 × 4 × 3	15	30 × 15 × 10	
9	6	4 × 3 × 2	12	28 × 14 × 12	
10	6	5 × 3 × 2	16	30 × 22 × 14	
11	5	4 × 3 × 3	14	28 × 19 × 11	
12	7	6 × 4 × 3	13	27 × 15 × 12	
13	6	5 × 4 × 2	14	29 × 16 × 14	
14	6	4 × 3 × 3	12	28 × 15 × 12	
15	5	3 × 3 × 2	14	27 × 22 × 11	

spontaneously in a dba mouse and upon microscopic examination was diagnosed as adenocarcinoma. It has been carried on since its discovery by means of successive transplants. In mice of the strain in which it originated it gives 100 per cent "takes." It grows rapidly, producing a tumor about 10 mm. in diameter four to five days following inoculation of the graft. The tumor kills the animal within two to three weeks, by which time it measures 30 to 40 mm. in diameter. It becomes hemorrhagic within ten to twelve days. It is soft in consistency.

The C3H strain of mice was established by Dr. Leonell C. Strong[2] of Yale University in 1920 and has been inbred since. This strain of mice has proved to be highly susceptible to spontaneous tumors of the mammary gland. Such a tumor, histologically diagnosed as an adenocarcinoma, was used for the present experiment, by transplanting from animal to animal of the same strain. The tumor "takes" were 90 to 100 per cent. No spontaneous regression of this tumor has ever been observed. The rate of growth is slower than that of the tumor in the dba strain, the latent period, *i.e.*, the time elapsing between the implantation of the graft and the occurrence of a measurable tumor, about 8 mm. in diameter, being ten to twelve days. The tumor grows progressively at a slow rate, measuring 25 to 30 mm. in diameter in five to six weeks. It is firm in consistency, encapsulated, and becomes hemorrhagic when it reaches a large size.

The first task was to determine the dose of x-radiation applied *in vitro* which would prevent an implant from producing a tumor in the animal organism. The same technic was used as in previous experiments (1). The surface portion of a eight- to ten-day tumor of the dba strain or of a twelve- to fourteen-day tumor of the C3H strain was cut with sharp scissors into fragments about 1.5 to 2.0 mm. in diameter and weighing about 10 to 15 mg. each. A portion of these tumor fragments was used for implantation into a number of control mice. Others were spread on a number 1 round cover slip attached to a mica sheet, covered with a Maximow slide, sealed with paraffin, and irradiated. The radiation was applied by a pulsating potential oil-cooled Coolidge tube. The radiation factors were: 200 kv., 20 ma., 0.5 mm. Cu plus 1.0 mm. Al filtration, 0.9 mm. Cu h.v.l. The distance of the tumor fragments from the target was 12.5 cm., and the average intensity was 604 r in air per minute. In figuring the dose received by the tumor fragments, the absorption of the radiation by the covering glass and mica sheet, which was about 10 per cent, was taken into consideration. The dose of radiation in each case was applied in a single exposure. Within fifteen

[2] I take this opportunity to express my sincere thanks to Dr. Strong for his kind co-operation in supplying mice for this study.

TABLE II: TUMORS PRODUCED BY IRRADIATED IMPLANTS IN dba STRAIN OF MICE
(200 kv., 20 ma., 0.5 mm. Cu + 1 mm. Al filter, h.v.l. 0.9 mm. Cu)

Experiment Number	Dose (r in air)	Latent Period (days)	"Takes" (per cent)	Average Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumor (mm.)
1	500	6	100	3 × 3 × 2	12	28 × 18 × 14
2	1,000	6–8	100	3 × 3 × 2	12	25 × 18 × 12
3	1,500	9–12	100	3 × 2 × 2	14	26 × 13 × 11
4	2,000	12–15	100	4 × 3 × 2	25	26 × 12 × 12
5	2,500	12–15	100	3 × 2 × 2	26	25 × 14 × 10
6	3,000	19–24	77.5	3 × 3 × 2	35	26 × 15 × 11
7	3,500	22–41	55.5	4 × 3 × 2	61	24 × 16 × 12
8	3,700	24–41	55.0	3 × 3 × 3	64	25 × 14 × 11
9	4,000	26–46	50.5	4 × 3 × 2	66	24 × 14 × 10
10	4,200	29–48	33.3	3 × 3 × 2	68	25 × 12 × 9
11	4,500	54	11.1	4 × 3 × 3	73	21 × 16 × 12
12	5,000	0	0	0	0	0

REMARKS: Each experiment included 12 to 15 mice. The sizes recorded represent averages of 12 to 15 tumors. The mice were killed when the tumors started to break through the skin.

to twenty minutes after irradiation, the tumor fragments were implanted into animals midway between the groin and the axilla by means of a trocar. Non-irradiated control implants were similarly implanted.

Both male and female mice were used in these experiments, weighing about 20 to 25 gm. The animals were fed with Purina dog chow and water *ad libitum*, with fresh carrots two to three times weekly. As criteria of the radiation effects, the latent period, the number of "takes," and the size of the tumors produced were taken into consideration. The same criteria were applied to tumors produced by non-irradiated implants in the control animal.

Histologically the tumor grown in the dba strain (Fig. 1) is a rather differentiated adenocarcinoma with instances of intra-acinar papilliform growth and variable development of stroma. It shows little tendency to necrosis, but a great tendency to hemorrhage. The nuclear structure is rather uniform, usually with reticular oval nuclei. There is a moderate tendency to hyperchromatism.

The tumor of the C3H strain (Fig. 2) is a solid type of epithelial growth with an alveolar arrangement of strands of tumor cells, scant stroma, polymorphous hyperchromatic nuclei, and a tendency to necrosis.

TUMOR GROWTH IN dba MICE

In Table I are recorded the characteristics of the tumor growth in controls of the dba strain. The latent period is seen to be between five and seven days. The average tumor size within this range is between 3 and 5 mm. in diameter. Within twelve to sixteen days the average tumor measured between 25 and 35 mm. in diameter. At this stage the tumors started to ulcerate and bleed. The animals were therefore killed and the experiment was terminated.

Doses up to 1,000 r in air applied to the tumor implants did not exert any apparent effect on their growth in the animal body. No increase in the latent period or decrease in the rate of growth of these implants was noticed as compared to non-irradiated control implants. As is shown in Table II, the first manifestation of radiation effect was observed in the latent period. Starting with a dose of 1,000 r in air, the latent period was prolonged with increase of the amount of radiation applied to the tumor graft, increasing from the usual six-day period to fifty-four days within the dose range of 1,000 to 4,500 r.

The average tumor size (initial and at the end of the experiment) produced by the irradiated implants showed no significant difference as compared to tumors produced by non-irradiated control implants. This

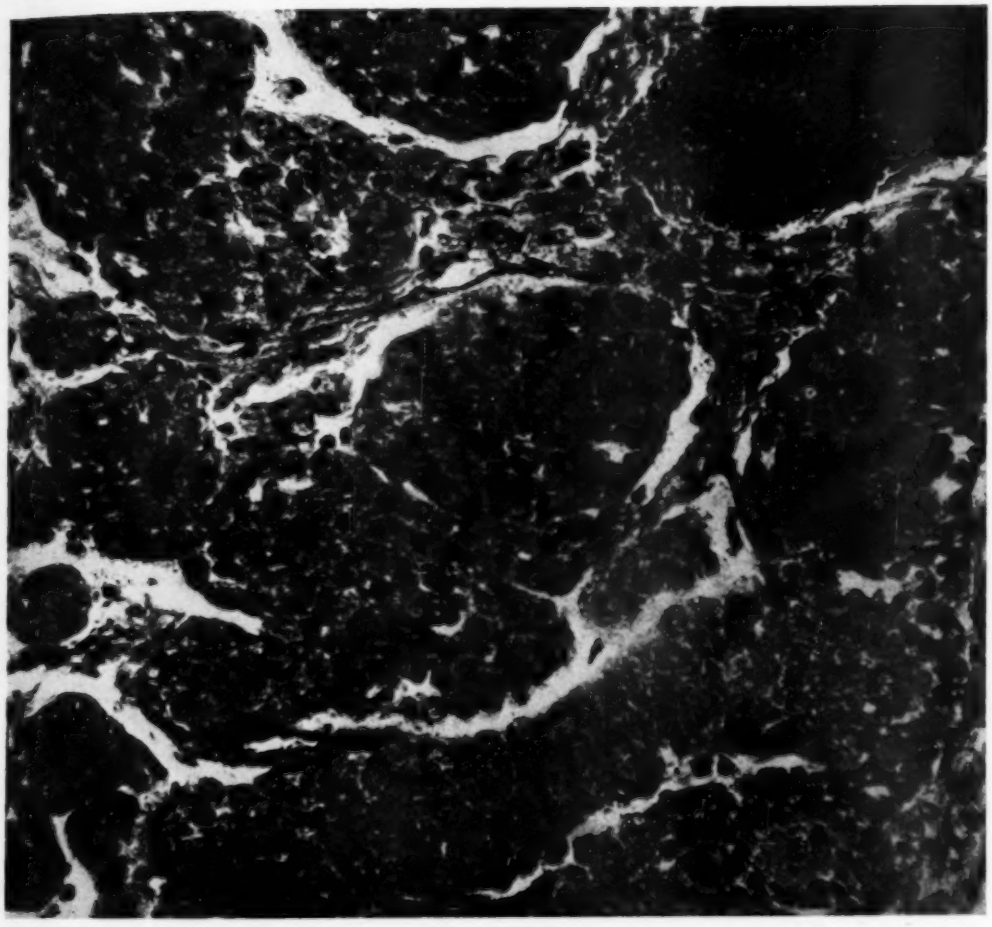

Fig. 1. Mammary adenocarcinoma grown in the dba strain of mice. × 425.

observation deserves special consideration in regard to the problem of recovery following irradiation. For example, it is apparent that an implant exposed to 4,500 r in air was able to produce a tumor of a large size following a latent period as long as fifty-four days. The question thus arises whether, after that interval, the irradiated tumor cells recovered following this massive dose to such an extent as to be able to propagate and produce a tumor, or whether a few cells escaped injury and, in order to produce a tumor of a detectable size, required a longer time. Further reference to this question will be made later.

TUMOR GROWTH IN C3H MICE

Table III sets forth the characteristics of the tumor growth in mice of the C3H strain following the inoculation of non-irradiated implants. The latent period varied between ten and twelve days. Within this period the implants produced tumors ranging between 2 and 3 mm. in diameter. Within thirty to forty days, the average tumor size was between 35 and 40 mm. (diameter).

In Table IV are recorded the characteristics of the tumor growth produced by irradiated implants in the C3H animals. Irradiation of the tumor grafts with doses

TABLE III: TUMORS PRODUCED BY NON-IRRADIATED CONTROL IMPLANTS IN C3H STRAIN OF MICE

Experiment Number	Latent Period (days)	Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumors (mm.)	Remarks
1	10	2 × 2 × 2	28	29 × 11 × 6	Each experiment included 12 to 15 mice. The tumor sizes reported in this table represent the average of 12 to 15 tumors. The mice were killed when the tumors started to break through the skin.
2	11	3 × 3 × 2	38	32 × 14 × 8	
3	10	3 × 2 × 2	45	39 × 18 × 12	
4	12	4 × 3 × 2	39	31 × 15 × 10	
5	12	3 × 3 × 3	42	35 × 20 × 14	
6	9	2 × 2 × 2	37	18 × 18 × 15 (I) 12 × 6 × 6 (II)	
7	12	4 × 3 × 3	43	38 × 19 × 11	
8	12	4 × 3 × 2	51	39 × 25 × 14	
9	10	3 × 2 × 2	43	37 × 18 × 10	
10	12	3 × 3 × 2	41	38 × 17 × 12	
11	12	3 × 3 × 3	38	37 × 15 × 10	
12	11	3 × 3 × 2	42	39 × 18 × 12	
13	10	3 × 3 × 2	39	40 × 18 × 15	
14	12	4 × 3 × 2	43	41 × 17 × 14	
15	12	3 × 3 × 3	37	38 × 18 × 16	

TABLE IV: TUMORS PRODUCED BY IRRADIATED IMPLANTS IN C3H STRAIN OF MICE
(200 kv., 20 ma., 0.5 mm. Cu + 1 mm. Al filter, h.v.l. 0.9 mm. Cu)

Experiment Number	Dose (r in air)	Latent Period (days)	"Takes" (per cent)	Average Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumors (mm.)
1	500	11	100	3 × 2 × 2	35	31 × 24 × 14
2	1,000	12–15	100	4 × 2 × 2	38	30 × 24 × 12
3	1,500	14–28	85	3 × 3 × 2	42	27 × 15 × 10
4	1,800	14–32	50	4 × 3 × 2	48	26 × 14 × 9
5	2,000	16–34	50	3 × 3 × 3	62	24 × 14 × 8
6	2,300	21–38	50	4 × 2 × 2	66	22 × 12 × 9
7	2,500	29–43	37.5	4 × 3 × 2	69	21 × 14 × 9
8	2,600	38	10	3 × 3 × 2	68	27 × 12 × 8
9	2,700	0	0	0	0	0

REMARKS: Each experiment included 12 to 15 mice. The sizes recorded represent averages of 12 to 15 tumors. The mice were killed when the tumors started to break through the skin.

up to 1,000 r did not exert any appreciable effect, either on the latent period or on the average tumor size. As in the experiments on the dba strain, the first effects were apparent with a dose of 1,000 r. This was again manifested by an increase of the latent period from the usual ten to twelve days up to fifteen days, progressing with the increase of the x-ray dose to thirty-eight days for implants irradiated with 2,600 r in air.

As to the average tumor size at the end of the experiment, there was no appreciable difference between tumors produced by irradiated implants and non-irradiated control implants. This observation, noted also in the experiments with the dba strain of mice, raised the same question of recovery following irradiation.

DISCUSSION OF RESULTS

A comparison of the observations made from these experiments with two inbred strains of mice and tumors autogenous to these strains reveals the following:

The tumors, although both histologically diagnosed as mammary adenocarcinoma, differ markedly as regards their growth potency and their radiosensitivity. These findings are apparent on a comparison of the latent periods and of the threshold doses of x-radiation, as shown in Tables II and IV and illustrated in graph form in Figure 3.

The implants of the mammary adenocarcinoma grown in the dba strain of mice have a latent period of five to six days and produce tumors averaging from 30 to 35 mm. in diameter within twelve to fifteen

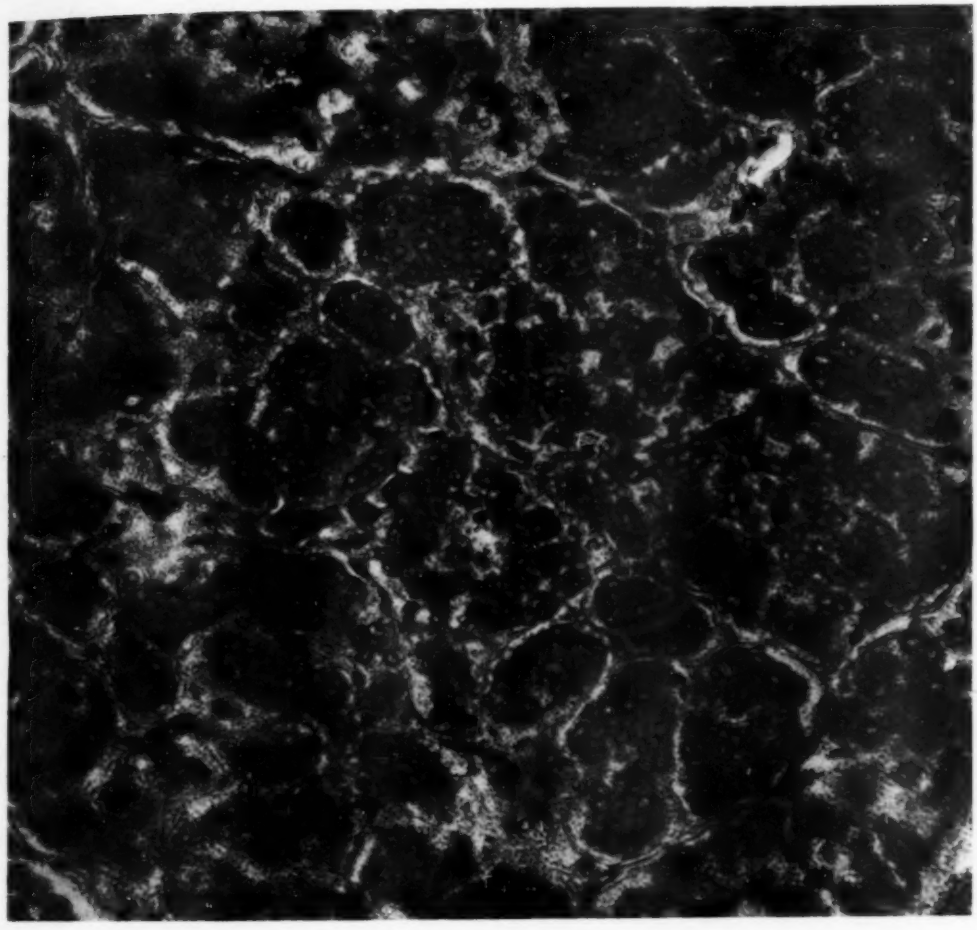

Fig. 2. Mammary adenocarcinoma grown in the C3H strain of mice. × 425.

days, with death of the animals shortly afterward. The latent period for implants of the adenocarcinoma grown in the C3H strain of mice is almost twice as long, namely ten to twelve days, and a longer time is therefore required to produce a tumor which will kill the host. Thus the average period of tumor growth in the C3H strain before death of the animal is about thirty to forty days as compared to twelve to sixteen days in the dba strain.

For the adenocarcinoma grown in the dba mice, a dose of 5,000 r in air was required to prevent the implant from producing a tumor, while for the adenocarcinoma grown in the C3H strain a dose of 2,700 r in air was sufficient to produce the same result.

Two points of major interest for radiation effects, particularly in therapy, emerge from the observations made in these experiments: (*a*) the radiosensitivity of tumors of similar histological structure; (*b*) the recovery process of tumor cells partially affected by radiation.

The radiosensitivity of a tumor is determined by the relationship between a given quantity of radiant energy and the biological effect which it produces. The accurate measurement of radiation presents no problem, so that it devolves upon the precise indication of the biological response

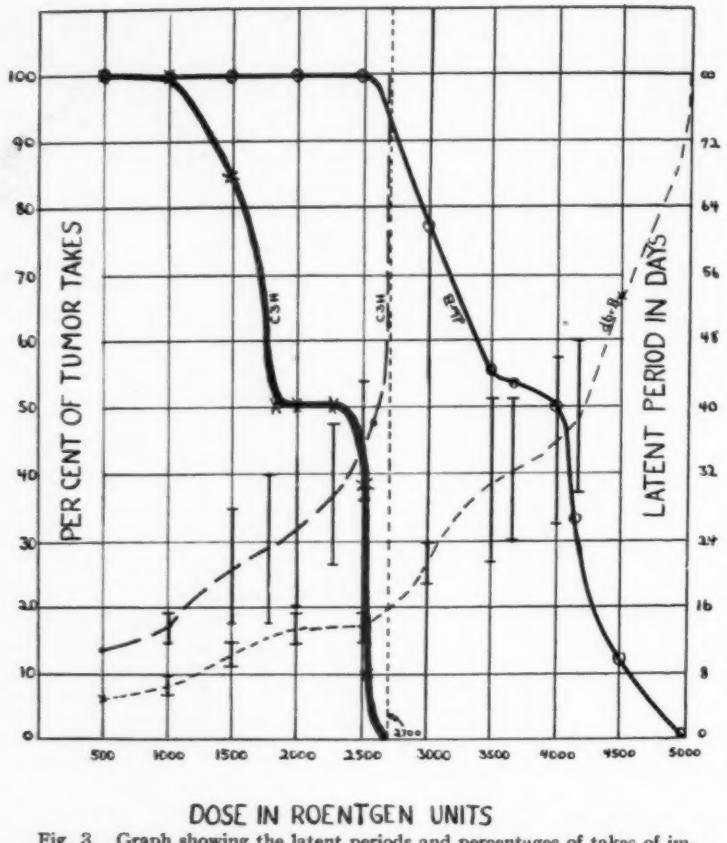

Fig. 3. Graph showing the latent periods and percentages of takes of implants of mammary adenocarcinomas grown in dba and C3H strains of mice following a single exposure to roentgen rays. The solid lines represent the percentage of "takes," the dotted lines the latent periods.

to determine with exactness the radiosensitivity of a given type of tumor. The customary biological indication is the destruction of viable tissue cells either *in vitro* or *in vivo*, so that the radiosensitivity has been measured in terms of the threshold or lethal doses. Thus, one might expect to obtain sensitivities of the same order for tumors of the same type as manifested by threshold doses of the same order of magnitude. In the experiments presented here, however, the threshold doses for two analogous mammary adenocarcinomas grown in their respective inbred strains showed a considerable difference in their radiosensitivity. How are we to account for the difference in radiosensitivity of these two tumors, both diagnosed as adenocarcinomas and each being autogenous to the strain in which it was grown? Are the biological factors which determine radiosensitivity characteristic of the tumor or of the host? In the light of these experiments, one may venture to state that certain intrinsic factors exist controlling the potentiality of tumor growth independent of histologic structure.

In reference to the recovery processes, it is of interest to note that tumor fragments of the dba strain, exposed to such high doses as 4,500 r in air, were able to produce tumors after as long a latent period as fifty-four days, while tumor fragments of the C3H strain of mice exposed to 2,600 r in air were able to do so after thirty-eight days.

As suggested above, this phenomenon is of importance for radiation therapy. In some cases and not in others, the dormant cells attenuated by certain doses of radiation may regain their growth potentiality and ultimately produce a tumor of a size comparable to that produced by non-irradiated cells. In this connection, reference may be made to the observation that viable cancer cells were present in human breast cancers which had been treated with high doses of radiation as much as one year previously (5). This observation has a direct bearing on the results presented in this paper.

CONCLUSION

In conclusion it may be stated that a more precise evaluation of the criteria for the radiosensitivity of a given type of tumor is indicated. It appears that histologic classification alone is an inconclusive guide to the specification of the proper therapeutic dose for any given tumor. In determining the threshold dose of radiation, due consideration should be given to biological factors characteristic of the tumor. Further studies along these lines are in progress. The phase of this work bearing on the production of immunity by means of attenuated implants is in progress and will be reported in a subsequent paper.

NOTE: The doses of roentgen rays determining the radiosensitivity of the tumors used in this investigation are obtainable under the experimental conditions outlined in the text. No references are available in the literature to these tumors under the conditions of the experiments here recorded.

The author wishes to express deep appreciation to Carl B. Braestrup, Senior Physicist, Department of Hospitals, and his associates for their cooperation in supplying the physical factors, to Dr. Ira I. Kaplan, Director of the Radiation Therapy Department, Bellevue Hospital, for the use of the x-ray apparatus, to C. Serber and B. Carl for administering the radiation treatments, and to Miss Annabelle Goldberg for laboratory assistance.

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New York 22, N. Y.

DISCUSSION

Friedrich Ellinger, M.D. (Brooklyn, N. Y.): Dr. Goldfeder's paper offers much material for discussion, presenting, as it does, evidence of immunity, recovery, and radiosensitivity. I am going to restrict my comments to the problem of radiosensitivity.

I believe that these observations present an interesting step forward in the understanding of an all-important problem. It is generally recognized that the particular radiosensitivity of malignant tumors means success or failure in radiation therapy. The analysis of the radiosensitivity of tumors has brought to light a number of factors, of which the degree of differentiation of the malignant tissue and the importance of the tissue of origin have been recognized as predominant.

In the light of present-day knowledge, tumors arising from radiosensitive tissues are considered as more radiosensitive than those originating from radioresistant tissues. The former are classified as constitutionally radiosensitive tumors, while the latter are considered as constitutionally radioresistant. This grouping of malignant tumors into constitutionally radiosensitive and constitutionally radioresistant permits a gross appraisal of their response to irradiation. The degree of differentiation, furthermore, determines to a large extent their individual radiosensitivity within these groups.

However, it is clinically well known that, in spite of identical morphologic and topical appearance of tumors, considerable differences in their response to irradiation may occur, for which no explanation is available so far. Dr. Goldfeder's observations seem to offer an answer to this problem by demonstrating the importance of the genetic make-up of the tumor host for the response of morphologically and topically identical tumors in mice. I would like to emphasize that her procedure of exposing the implant *in vitro* and

re-implanting it into a new host of the same strain excludes all possible influences of the tumor bed.

The demonstration of the importance of the genetic factor in the radiosensitivity of malignant tumors, accounting for as much as 50 per cent difference, appears equally significant from the theoretical and the clinical standpoint. The observations of Dr. Goldfeder offer a new and strong argument in favor of individualization and against schematization in radiation therapy of malignant tumors.

Paul C. Aebersold, Ph.D. (Oak Ridge, Tenn.): This type of experimentation is necessary in understanding the problems of growth. I would like to add that it ties in with what Dr. Kamen had to say yesterday, that there is a biochemical factor produced by radiation. This was demonstrated in Dr. Goldfeder's experiments, although we don't understand what has happened, by the fact that putting an irradiated transplant into an animal causes some degree of immunity to a subsequent transplant. It follows that some biochemical factor is liberated by an irradiated cell which can then affect the growth of other cells.

The important point is to get more information of this type and then to seek to determine, as Dr. Kamen and others are doing, what is the biochemical growth-blocking factor produced by irradiating a cell. That is, there is some enzyme or other biochemical factor necessary for normal growth which is blocked in its action as the result of the irradiation.

Dr. Goldfeder's work aims at observing how the biochemical agent liberated by a group of cells affects the growth of another group of cells introduced into the same host. By isotopic tracer or biochemical methods we should investigate this type of factor more thoroughly.

Anna Goldfeder, Sc.D. (*closing*): I wish to thank Dr. Aebersold. He has brought out the point of immunity to malignant growth. When I started my experiments, my idea was not to utilize this procedure to immunize animals against malignant growth but, as I have mentioned, to compare the effects of radiation *in vitro* and *in situ*. When I looked for an explanation why a very large dose is necessary to destroy tissue cells *in vitro* when a much smaller dose will prevent their proliferation *in situ*, I utilized the phenomenon that if a tumor implant fails to produce a tumor, or if a tumor regresses spontaneously, the host becomes immune or resistant to further viable tumor grafts. Such a phenomenon was, in fact, produced by tumor grafts attenuated with specific doses of radiation. The factor which produces the resistant state—whether it is of a chemical nature or is a virus or of any other specificity—is not as yet determined. The isolation of such a principle from a tissue cell—one which could produce immunity to malignant growth—would be a discovery of the first importance.

SUMARIO

Efectos de los Rayos X sobre los Tumores Mamarios Autógenos en Razas Entrecruzadas de Ratones

Los experimentos ejecutados en ratones de dos razas entrecruzadas, dba y C3H, se proponían determinar el efecto de los rayos X aplicados a implantes de tumores antes de inocularlos.

Los tumores provocados en las dos razas eran, histológicamente, semejantes, siendo en ambas adenocarcinomas mamarios, pero variaron con respecto al período de latencia consecutivo al implante y en la velocidad de su desarrollo. También discreparon en su radiosensibilidad. Para el tumor de desarrollo más rápido (en la raza dba) se necesitó una dosis de 5,000 r (en el aire) para impedir que el implante produjera un tumor en tanto que en el otro bastó con una dosis de 2,700 r para producir el mismo efecto. A juzgar por esto, existen ciertos factores intrínsecos que rigen la potencialidad de la carcinogenia aparte de la estructura histológica.

Se observó igualmente que los implantes neoplásicos expuestos a altas dosis de rayos X eran capaces de producir tumores tras un período excesivamente largo de latencia (54 días, comparado con un período normal de 5 a 7 días en una raza y 38 días, comparado con un período normal de 10 a 12 días en la otra), lo cual sugiere que en algunos casos las células atenuadas por la radiación pueden recuperar su potencialidad de desarrollo y producir por fin un tumor comparable al producido por las células no irradiadas.

EDITORIAL

Cerebral Angiography

For a good many years, dating well back in the past quarter century, various segments of the circulatory system have been subjected to x-ray examination following the introduction of opaque material into the blood stream. At the outset this form of examination was limited to the preparation of arteriograms and phlebograms of extremity vessels in the case of peripheral vascular diseases. Bolder attempts to use halogenated oil in small quantities to observe the nature of blood currents within the beating heart were sufficiently well advanced to be presented at the International Congress of Radiology held in Chicago in 1937, and there have been several exhibits at roentgenological meetings to demonstrate the diagnostic possibilities which attend the introduction of opaque material into the abdominal aorta and its branches by means of direct arterial puncture. More elaborate perfusion technics designed to permit investigation of the circulation through the chambers and great vessels of the heart itself have come into fairly wide vogue. This has been accomplished by means of rapid injections of concentrated halogenated substances into large peripheral veins and also by introduction of the material close to the right auricle by way of sizable catheters slipped down through the veins which empty into that structure.

The great rapidity of circulation time, the speed with which opaque materials are diluted by the blood stream, and the necessity for great caution in avoiding thrombosis and the extravasation of the opaque medium have served to prevent all of these highly specialized technics from being applied very widely in comparison to the enormous volume of diagnostic radiological procedures which are conducted throughout the world each year.

Egas Moniz is to be credited with the first published attempts to examine the cerebral circulation in living man by means of opaque perfusion. His original report appeared in July 1927 (L'encéphalographie artérielle, son importance dans la localisation des tumeurs cérébrales. Rev. neurol. **2:** 72–90, 1927). Following that beginning, made just twenty years ago, cerebral angiography has grown in favor as a useful device in intracranial diagnosis at a rate which is appropriately related both to the inherent hazards of the procedure and to the brilliant diagnostic results which it is capable of producing.

Although perfusion of the cerebral vessels with an opaque substance can be performed with little or no risk to the patient, and will provide skull roentgenograms of great diagnostic value, it does not follow that this method of study should ever be used as extensively as many other accepted methods of examination. For reliable end-results, a superlative degree of co-operation between the radiologist and his neurosurgical colleague is essential. The procedure is one which should be used only when simpler methods of examination have failed to answer with sufficient accuracy some difficult problem of intracranial diagnosis. Its utility is very largely limited to investigation of the circulation within the supratentorial portion of the cranial cavity. While it is possible to inject the major vessels in the posterior fossa of the skull, the technic involved is considerably more difficult except in those rare instances when introduction of the opaque material by the usual internal carotid route results in adequate filling of

subtentorial vessels by way of the posterior communicating artery.

It is felt by some workers in this field that the procedure may be simplified considerably if indirect puncture of the carotid is accomplished through the intact skin, thus obviating the necessity for surgical exposure of the vessel. There are those who believe, however, that when the information to be derived from angiography is sufficiently important to the clinical problem in hand, the niceties of technic which are made possible by surgical exposure of the internal carotid, as well as the prevention of possible and undesirable extravascular leakage, amply justify the more elaborate procedure of direct injection into the blood stream. The details of both technics are readily available in recently published articles on the subject.

As yet, no truly ideal material has been made available for this particular type of contrast radiography. Substances which are readily tolerated in peripheral vessels, as well as the circulation through the heart, cannot be used in the cerebral circulation if they are known to produce profound brain irritation. One opaque substance which is singularly free from this undesirable property, thorotrast, is used with justifiable reluctance by radiologists and neurosurgeons because of its inherent and prolonged radioactivity. Thorium dioxide is excreted very slowly indeed after injection; the major portion being stored in the reticulo-endothelial system. Once more, if the procedure is begun with careful consideration for the necessity of the examination and the likelihood that it will produce information of great value, careful planning of the technic to be used will permit the satisfactory employment of a sufficiently small amount of thorium dioxide to prevent the accumulation of amounts within the body which can possibly constitute a threat of serious toxic end-results. If used in amounts which have been shown to be innocuous, thorium dioxide (thorotrast) is a suitable contrast material.

Cerebral angiography owes its diagnostic successes to three characteristic groups of findings, each of which has peculiar advantages. In the case of intracranial lesions which involve the circulatory system primarily, it is possible by means of the angiographic procedure to obtain direct information regarding the location and character of the lesion. For example, cerebral aneurysms, whether they involve the internal carotid in its cavernous sinus segment at the base of the brain, or more peripheral branches, can be observed with the greatest ease and clarity in contrast to the less definitive signs which depend upon erosion of neighboring bone. By the same token, obliteration of vascular channels, either partial or complete, can be identified and localized with a high degree of certainty. Tumors generously supplied with blood vessels can be seen in their own right in properly prepared roentgenograms when these mazes of tumor vessels are momentarily filled with opaque material. It is possible on the basis of the critical study of resulting roentgenograms to identify the particular tumor involved when cerebral angiograms are available. This is particularly true in the case of most glioblastomas. Over and above the diagnostic findings which are uniquely characteristic of cerebral angiograms, evidences of vascular displacement, comparable to the signs of ventricular displacement obtained in ventriculography, can be utilized advantageously in the localization of intracranial tumors.

The combined neurosurgical and radiological procedure of cerebral angiography has won for itself during the past twenty years a well established position. While it is not a procedure to be used indiscriminately and inadvisedly, there will always be found, in every clinic where any considerable volume of intracranial disease is being apprehended and treated, problem cases which do not lend themselves to less elaborate methods of study. Reserved for use in this field, cerebral angiography represents a significant milestone in the never ending advancement of diagnostic roentgenology.

FRED J. HODGES, M.D.

PITTSBURGH ROENTGEN SOCIETY

The newly elected officers of the Pittsburgh Roentgen Society are Dr. H. N. Mawhinney of Pittsburgh, President; Dr. Joseph Danzer of Oil City, Vice-President; Dr. R. P. Meader of Pittsburgh, Secretary-Treasurer.

UROLOGY AWARD

The American Urological Association offers its annual award of $1,000 (first prize $500, second prize $300, and third prize $200) for essays on the result of some clinical or laboratory research in urology. The competition is limited to urologists who have been in such specific practice for not more than five years and to residents in urology in recognized hospitals. Full particulars may be obtained from the Secretary, Dr. Thomas D. Moore, 899 Madison Ave., Memphis, Tenn. Essays must be in his hands before March 1, 1948.

SCIENTIFIC BOOKS FOR FINLAND

A communication from the American Friends Service Committee tells of the need of scientific and technical books to reconstruct the library of the Technical Institute at Helsinki, Finland, destroyed by bombing during the war. In the remarkable efforts for recovery that the Finns are making, the lack of technical library facilities is a serious handicap. It would be a practical act of friendship to a nation that holds America in high regard if Americans should contribute good technical books and periodicals to this library.

Any such gifts should be marked for the Institute of Technology, Helsinki, and sent to the Legation of Finland, 2144 Wyoming Ave., N. W., Washington, D. C. Dr. K. T. Jutila, the Finnish Minister, will arrange for their shipment to Finland.

Book Reviews

PRACTICAL X-RAY TREATMENT. By ARTHUR W. ERSKINE, M.D. A volume of 155 pages with 22 illustrations. Published by The Bruce Publishing Company, St. Paul and Minneapolis, 3d edition. 1947.

Though the author does not attempt to answer the several questions raised in the introduction to the Second Edition of his "Practical X-ray Treatment," he has succeeded in enhancing the concentrated information found in the earlier editions of the work. The book is a practical guide for the student or roentgenologist seeking useful material on roentgen therapy presented in a concise, clear, but admittedly somewhat dogmatic manner. It enables the experienced radiologist to compare his own results with those obtained by the author's methods.

The first eight chapters deal primarily with the physical side of roentgenology, covering current apparatus, protection, measuring instruments, both direct and indirect, factors affecting skin dosage and depth dosage, standard technics, scattering and distribution, determination of skin dose, and the effects of radiation on normal and abnormal tissues. Three technics at 135 kv.p. and one at 200 kv.p. are described, with various modifications. Included are fourteen useful depth-dose charts covering various field sizes and anode-skin distances through a range of qualities from half-value layers of 1.0 mm. aluminum to 2.0 mm. copper.

There follow chapters on the treatment of skin diseases, infections, non-malignant, and finally malignant neoplasms. A philosophical chapter entitled "The Cancer Problem and the Radiologist" is an erudite discussion by one who has dealt with cancer patients from the early days of radiation therapy.

One criticism of the work might be its brevity in the actual description of the treatment of malignant disease. There is still much room for extension in that detail without defeating the avowed purpose of the book.

In Memoriam

EDWARD EVERETT ROWELL, M.D.

1878–1947

Dr. Edward Everett Rowell, a member of the Radiological Society of North America since 1927, died on July 13, at the age of sixty-eight. Dr. Rowell was graduated from the Hahnemann Medical College and Hospital of Philadelphia in 1899. He was radiologist on the staff of the Greenwich Hospital, Greenwich, Conn., and of the Norwalk General Hospital, Norwalk. He was a diplomate of the American Board of Radiology, a fellow of the American College of Radiology, and a member of the American Roentgen Ray Society.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates. Address: Howard P. Doub, M.D., The Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 607 Medical Arts Bldg., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Hugh F. Hare, M.D., 605 Commonwealth Ave., Boston 15, Mass.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Harold Dabney Kerr, M.D., Iowa City, Iowa.

AMERICAN COLLEGE OF RADIOLOGY. *Secretary*, Mac F. Cahal, 20 N. Wacker Dr., Chicago 6, Ill.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Courtney S. Stickley, M.D., Bell Bldg. Montgomery. Next meeting at the time and place of the Alabama State Medical Association meeting.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and annually at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

LOS ANGELES COUNTY MEDICAL ASSOCIATION, RADIOLOGICAL SECTION. *Secretary*, Moris Horwitz, M.D., 2009 Wilshire Blvd., Los Angeles 5. Meets second Wednesday of each month at County Society Bldg.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

SAN DIEGO ROENTGEN SOCIETY. *Secretary*, R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Ivan J. Miller, M.D., 2000 Van Ness Ave. Meets monthly on the third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Toland Hall, University of California Hospital.

Colorado

DENVER RADIOLOGICAL CLUB. *Secretary*, Mark S. Donovan, M.D., 306 Majestic Bldg., Denver 2. Meets third Friday of each month, at the Colorado School of Medicine and Hospitals.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Robert M. Lowman, M.D., Grace-New Haven Hospital, Grace Unit, New Haven. Meetings bimonthly, second Thursday.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Beals, M.D., St. Luke's Hospital, Jacksonville. Meets semiannually, in April, preceding the annual meeting of the Florida Medical Society, and in November.

Georgia

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert Drane, M.D., De Renne Apartments, Savannah. Meets in November and at the annual meeting of State Medical Association.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, T. J. Wachowski, M.D., 310 Ellis Ave., Wheaton. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April, at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly as announced.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, J. A. Campbell, M.D., Indiana University Hospitals, Indianapolis 7. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney E. Johnson, M.D., 101 W. Chestnut St., Louisville.

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, Everett L. Pirkey, Louisville General Hospital, Louisville 2. Meets second Friday of each month at Louisville General Hospital.

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday, 7:30 P.M.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary*, Harry A. Miller, 2452 Eutaw Place, Baltimore.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, at Wayne County Medical Society club rooms.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS. *Secretary-Treasurer*, R. B. MacDuff, M.D., 220 Genesee Bank Building, Flint 3.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, C. N. Borman, M.D., 802 Medical Arts Bldg., Minneapolis 2. Regular meetings in the Spring and Fall.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, John W. Walker, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ralph C. Moore, M.D., Nebraska Methodist Hospital, Omaha 3. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary-Treasurer*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meetings quarterly in Concord.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Raphael Pomeranz, M.D., 31 Lincoln Park, Newark 2. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway, L. I.

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Abraham H. Levy, M.D., 1354 Carroll St., Bklyn. 13. Meets fourth Tuesday of every month, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month, October to May, inclusive.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary-Treasurer*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meetings in January, May, and October.

LONG ISLAND RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Wm. Snow, M.D., 941 Park Ave., New York 28.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary*, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Charles Heilman, M.D., 1338 Second St., N., Fargo.

Ohio

OHIO RADIOLOGICAL SOCIETY. *Secretary*, Carroll Dundon, M.D., 1030 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association, May 1948.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Edward T. Kirkendall, M.D., 700 North Park St., Columbus 8.

CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Eugene L. Saenger, M.D., 735 Doctors Bldg., Cincinnati 2. Meets last Monday of the month, September to May.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George L. Sackett, M.D., 10515 Carnegie Ave., Cleveland 6. Meetings at 6:30 P.M. on fourth Monday, October to April, inclusive.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Peter M. Russo, M.D., 230 Osler Building, Oklahoma City. Meetings three times a year.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wm. Y. Burton, M.D., 242 Medical Arts Bldg., Portland 5. Meets monthly, on the second Wednesday, at 8:00 P.M., in the library of the University of Oregon Medical School.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Calvin L. Stewart, M.D., Jefferson Hospital, Philadelphia 7. Meets first Thursday of each month at 8:00 P.M., from October to May in Thomson Hall, College of Physicians, 21 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, R. P. Meader, M.D., 4002 Jenkins Arcade, Pittsburgh 22. Meets second Wednesday of each month at 6:30 P.M., October to June.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., Lincoln Clinic, Lincoln, Nebr.

South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

Tennessee

MEMPHIS ROENTGEN CLUB. Meetings second Tuesday of each month at University Center.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frére, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth 2. Meetings on third Monday of each month in Dallas in the odd months and in Fort Worth in the even months.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth 4. Next meeting Jan. 17, 1948.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, M. Lowry Allen, M.D., Judge Bldg., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

UNIVERSITY OF UTAH RADIOLOGICAL CONFERENCE. *Secretary*, Henry H. Lerner, M.D. Meets first and third Thursdays, September to June, inclusive, at Salt Lake County General Hospital.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, E. Latan Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Homer V. Hartzell, M.D., 310 Stimson Bldg., Seattle 1. Meetings fourth Monday October through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day meeting in May and one day at annual meeting of State Medical Society in September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursdays 4 to 5 P.M., September to May, inclusive, Room 301, Service Memorial Institute, 426 N. Charter St., Madison 6.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, E. M. Crawford, M.D., 2100 Marlowe Ave., Montreal 28, Quebec. Meetings in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origéne Dufresne, M.D., Institut du Radium, Montreal. Meets on third Saturday of each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA. *General Secretary*, Dr. Dionisio Pérez Cosío, Marsella 11, México, D. F. Meetings first Monday of each month.

ABSTRACTS OF CURRENT LITERATURE

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Penicillin in the Treatment of Infections in the Nasal Passages and Sinuses. Richard E. Dunn. Australian & New Zealand J. Surg. **16:** 163–181, January 1947.

This paper is an account of the use of penicillin as an adjunct in the treatment of infections of the nose and accessory sinuses. Before treatment was instituted, x-ray studies of the sinuses were made, antral puncture was done, and antral washings were obtained. The treatment was undertaken only in those cases in which the presence of penicillin-sensitive organisms were found to be present. In patients with sinus symptoms x-ray examination was particularly helpful, not only in the diagnosis of sinusitis, but also in determining which sinuses were involved. Only by this means could the most effective method of applying penicillin in a given case be ascertained.

Four methods of administration are described: (1) local application by (*a*) displacement of air from the sinuses, (*b*) nasal drops, (*c*) antral puncture and instillation, or (*d*) continuous irrigations; (2) intramuscular injection; (3) local application combined with oral administration of sulfamerazine; (4) intramuscular and local application combined.

Initial and repeat roentgenograms were employed to determine the most efficacious route for penicillin administration in a given case, as well as to follow the clinical response to treatment.

Six cases are described in detail and a summary of 79 cases is presented in table form. While the majority of the patients claimed relief of symptoms and showed roentgen evidence of improvement, the author believes that the response to other conservative measures would have been equally good. LOUIS BERNSTEIN, M.D.

Adamantinoma of the Maxillary Sinus: Report of Two Cases. George S. Richardson. Ann. Otol., Rhin. & Laryng. **55:** 914–931, December 1946.

Two cases of adamantinoma of the maxillary sinuses are reported, one of which presented an atypical and the other a typical microscopic picture. This tumor has been adequately defined as an "epithelial tumor arising from the odontogenic apparatus or from cells with a potentiality for forming tissues of the enamel organ." The commonest sites are the mandible, maxilla, tibia, and hypophyseal body, probably in that order.

The tumor may arise as a solid growth and become cystic, or it may arise as either a solid or cystic type and so remain. A wide age range is noted, but the greatest incidence is in the late third and early fourth decade of life.

Adamantinoma, like other antral tumors, may be suggested by a careful history, eliciting earlier dental trauma or a unilateral nasal obstruction of long standing with mucopurulent or serosanguineous discharge. Symptoms include fetor, occasionally frontal headache, cranial nerve disturbances involving the first, second, third, fourth and fifth nerves, and external deformity.

Chont (Am. J. Roentgenol. **50:** 480, 1943. Abst. in Radiology **42:** 511, 1944) considers adamantinoma quite characteristic roentgenologically. The solid adamantinoma, he believes, has a monocystic appearance on the x-ray film, interrupted by small niches on the border of the bony defect. This produces a more or less lobulated appearance and a few fine bone trabeculae to differentiate it from odontogenic cysts with their smooth borders. The polycystic type reveals a honeycomb appearance in the early stage. Tooth elements may or may not be contained, but the round cystic compartments are quite characteristic.

The roentgenologic diagnosis of any antral tumor depends upon the familiarity of the roentgenologist with the behavior of the tumor in that location. Certainly all adamantinomas do not necessarily become encapsulated in a bony shell, nor produce large, bulging external deformities.

The roentgenograms in one of the author's cases showed nothing of significance other than bone destruction, while the other presented certain of the characteristics outlined by Chont, namely, a monocystic appearance with small niches in a bony trabecula through the midportion of the sinus, while subsequent films revealed a honeycomb appearance with round, cystic compartments.

Adamantinomas are malignant, invasive, and comparatively slow growing. For a favorable prognosis they must be recognized promptly, be radically and thoroughly treated by early and adequate surgery, and watched frequently for recurrence. Irradiation affords little or no benefit in halting progress of the tumor.

STEPHEN N. TAGER, M.D.

Recurrent Parathyroid Adenoma: A Case Report Lloyd B. Burk, Jr. Surgery **21:** 95–101, January 1947.

This case report illustrates the recurrence of benign parathyroid adenoma from a transplant of the tumor left in at the first operation.

Diagnosis of hyperparathyroidism in a 31-year-old white male was established through the following roentgenographic changes: (1) prominence of the trabecular pattern and decalcification throughout the entire skeleton, especially the skull; (2) cystic changes in the tibial condyles bilaterally, the lateral condyle of the left femur, the 4th, 5th, 6th and 7th ribs on the right, and the 3d rib on the left, with two fractures; (3) marked calcium deposition in the parenchyma of both kidneys; (4) absence of the lamina dura of the teeth. Laboratory findings confirmed the diagnosis, and a tumor was palpable just to the left of the trachea and above the sternum. At operation, as a safeguard against development of hypoparathyroidism, a small fragment of the adenoma was transplanted beneath the sternothyroid and sternohyoid muscles.

Two years later, the patient was again seen with a tumor at the site of the transplant and recurrent manifestations of hyperparathyroidism. The tumor was excised. Pathologically it resembled the original adenoma, though some of the cells were less typical, showing mild pleomorphic and hyperchromatic changes. Neither tumor is considered malignant. The patient was free of symptoms after the second operation, and x-ray examination showed complete recalcification of the skull and partial remineralization of the cervical spine. The cystic areas were nearly recalcified.

J. E. WHITELEATHER, M.D.

THE CHEST

Disseminated Pulmonary Calcification: A Report of 113 Cases. Robert H. High, Henry B. Zwerling, and Michael L. Furcolow. Pub. Health Rep. **62:** 20–29, Jan. 3, 1947.

The literature on pulmonary calcification is reviewed, and a study of 113 cases is presented. In every instance five or more calcareous deposits were present in each lung field, scattered over at least half the field. The films were studied by two "readers," and were reviewed by both, first separately and then together, so that the findings were as objective as possible. Tuberculin and histoplasmin skin tests were made on these patients and interpreted according to well established standards.

Two types of disseminated calcification were recognized: miliary calcification and multiple bilateral calcification. The distinction is interesting, since most observers feel that the miliary type results from hematogenous dissemination of the causative agent, whereas the multiple bilateral type is the result of bronchogenic dissemination. Illustrations of both types are included.

Sixty-four of the 113 cases studied were previously reported by Furcolow, High, and Allen (Pub. Health Rep. **61:** 1132, 1946), having been found among 6,528 school children in Kansas City, Mo. The remaining 49 cases were collected from various sources. The authors analyze each of these groups separately, as well as giving the figures for the two combined. Of the 113 persons showing pulmonary calcifications, 108 were tested with both histoplasmin and tuberculin: 86.1 per cent reacted positively to histoplasmin but not to tuberculin; 10.2 per cent reacted positively to both; 3.7 per cent were negative to both; none gave a positive reaction to tuberculin and a negative reaction to histoplasmin. Summing up these observations, it is found that 96.3 per cent gave positive histoplasmin reactions as compared to 10.2 per cent reacting to tuberculin.

In 69 of the 113 cases, or 61.1 per cent, the pulmonary calcification was of the multiple bilateral type, and in 44, or 38.8 per cent, of the miliary type. Calcifications were present in the hilar structures in 73.5 per cent of the former group and in only 50 per cent of the latter. No significant differences were observed in the skin reactions in these two groups.

The authors conclude that their findings constitute strong evidence that disseminated calcifications in the lungs "are not frequently caused by tubercle bacilli, but probably by the agent producing sensitivity to histoplasmin." Two interesting observations were the lower incidence of chest calcification in Negroes and the demonstration of a definite familial relationship.

An excellent bibliography on pulmonary calcification is appended. To this might be added a paper by Frimann-Dahl and Waaler appearing in 1936 as Supplementum 33, Acta radiologica. This was suggested by one of the authors (H. B. Z.).

SYDNEY F. THOMAS, M.D.

Nontuberculous Pulmonary Calcification and Histoplasmin Sensitivity. Robert H. High. Pennsylvania M. J. **50:** 384–387, January 1947.

Calcareous deposits in the pulmonary parenchyma and tracheobronchial lymph nodes have generally been considered the result of healed tuberculosis. It has been found, however, that many patients with such calcification do not react to tuberculin and that areas of this country with a high frequency of calcification in the chest are not necessarily those with high mortality rates for tuberculosis.

Earlier investigators were able to demonstrate that pulmonary infections with *Coccidioides immitis* could cause calcification in the chest, but no significant correlation could be established between the pulmonary condition and coccidioidin sensitivity. It was noted by Smith (M. Clin. North America **27:** 790, 1943) that most cases of histoplasmosis (caused by *H. capsulatum*) had occurred in areas where a high incidence of calcification in the chest was seen, and as antigen from this fungus was available, groups of nurses were tested for sensitivity. This was done on the theory that, like coccidioidomycosis, histoplasmosis might occur in an unrecognized benign form which would cause pulmonary calcification. The number of positive reactors to histoplasmin has shown wide variation geographically. It has been found, however, by various observers that far more patients with lung calcification react positively to histoplasmin than to tuberculin. Of one group of 3,105 nurses, 294 showed pulmonary calcifications, and of these, 63 gave positive reactions to tuberculin, 206 to histoplasmin, 26 to neither. There is as yet, however, no proof that histoplasmin sensitivity is caused by present or past infections with *H. capsulatum*.

It is emphasized that in most instances it is impossible to distinguish between tuberculous and non-tuberculous calcification roentgenographically, though some workers have attempted to show that disseminated or "wheatena-like" calcifications are caused by the agent producing histoplasmin sensitivity.

JOSEPH T. DANZER, M.D.

Tuberculosis Case Finding. A Comparison of the Effectiveness of Various Roentgenographic and Photofluorographic Methods. Carl C. Birkelo, W. Edward Chamberlain, Paul S. Phelps, Percy E. Schools, David Zacks, and Jacob Yerushalmy. J. A. M. A. **133:** 359–365, Feb. 8, 1947.

In 1944 the Veterans Administration recognized the need for comprehensive evaluation of different roentgenographic and photofluorographic methods, and a Board of Roentgenology, aided by a statistician, was appointed. The Board consisted of two radiologists and three chest specialists. The conditions of mass survey work were simulated as closely as possible for the various technics employed. Manufacturers provided the machines and made special efforts to produce films of the best possible quality. For each one of 1,256 individuals a 14 × 17-inch celluloid film, 35-mm. and 4 × 10-inch photofluorograms, and 14 × 17-inch paper negatives were obtained on the same visit. These sets of films were then interpreted independently by the five members forming the Board of Roentgenology.

An agreement on nomenclature and code for classifying the films into categories as uniform as possible was made before any of the films in the survey were reviewed. Each reader then received only one set of films at a time. The 14 × 17-inch celluloid films were read last in the series and after a wait of two months were again read by each reader.

The results were found to justify the conclusion that no one of the methods, not even the 14 × 17-inch celluloid, is superior for case-finding purposes to any other method. The miniature technics showed slight over-reading by one reader, but it is felt that this handicap can be overcome by personal training.

Striking disagreement of the readers with one another regarding the presence or absence of tuberculosis was found. In some cases 20 per cent of the films which were called positive for tuberculosis by one reader were read as negative by another. Furthermore, there was great variation in the ability of an individual reader to be consistent with himself in two independent interpretations of the same set of 14 × 17-inch celluloid films.

Two suggestions are made: (1) that a revision of the method of classifying films is needed, such a revision to be based on an extensive study and actual experimentation; (2) that in mass survey work all films be read independently by at least two interpreters and that all persons whose films are selected as positive or suggestive for tuberculosis by one or the other interpreter be recalled for further study.

L. A. POZNAK, M.D.
(University of Michigan)

Discrepancies Between Clinical-Radiological and Bronchospirometric Findings. Raúl F. Vaccarezza, Alfredo Lanari, and Alberto Soubrié. Am. Rev. Tuberc. **55:** 128–143, February 1947.

By means of bronchospirometry the functional capacity of each lung can be determined separately. The author presents a series of cases in which the clinical and radiographic findings were at variance with those obtained by bronchospirometry. In each of these the lung appearing more severely involved by disease revealed the better pulmonary respiratory function. Upon analysis, the causes for this discrepancy were found to be as follows:

1. *Pulmonary Factors:* Emphysema or diffuse fibrosis may pass unnoticed or be underestimated in the roentgenogram. Small parenchymal lesions may be unobserved.

2. *Bronchial Factors:* Bronchial lesions may interfere greatly with ventilation due to partial stenosis.

3. *Pleural Factors:* Pleural thickening and adhesions frequently diminish the functional capacity of the corresponding lung. These lesions are not always apparent in roentgenograms.

4. *Changes in the Chest Wall:* Muscular atrophy, phrenic paralysis, or pain on one side may seriously affect the pulmonary function.

It is concluded that bronchospirometric examination should be done in all patients who are to be submitted to surgical collapse therapy, since this method may show that the contralateral lung has insufficient functional capacity to allow collapse of the opposite side.

L. W. PAUL, M.D.

Bronchiectasis: A Neglected Disease. William M. Kinney. Dis. of Chest **13:** 33–47, January–February 1947.

The author made the diagnosis of bronchiectasis 59 times with the aid of bronchography during a period of eighteen months, while on duty on the general chest service of a naval hospital. During this time, 9,754 patients were admitted to the hospital. The incidence of bronchiectasis was thus 0.6 per cent, representing the largest non-tuberculous group of chronic pulmonary diseases. The condition followed pneumonia in 29 cases, upper respiratory infection in 15, asthma in 2, scarlet fever in 2, whooping cough in 2, measles in 1, lung abscess in 1, inhalation of poison gas in 1. In 6 there was no known antecedent illness. The ages by decades for the onset of symptoms were as follows: from 1 to 10 years, 16; 11 to 20 years, 18; 21 to 30 years, 19; 31 to 40 years, 6.

The duration of the symptoms was under six months in 24 cases; 7 to 12 months in 5; 1 to 2 years in 3; 2 to 3 years in 1; 3 to 4 years in 2; 4 to 5 years in 1; 5 to 10 years in 9; 10 to 15 years in 5; 15 to 20 years in 4; 20 to 25 years in 5. The group of 24 with symptoms of less than six months' duration had had a streptococcal pneumonia, contracted during an epidemic at one of the training camps. Cough and expectoration were present in all cases, but in only 2 was the sputum foul. The majority of the patients complained of increased susceptibility to respiratory infections. Hemoptysis and pulmonary hemorrhage were present in 19 cases. Dyspnea on exertion was complained of by 6. Clubbing of the fingers was present in 1 case only.

The roentgen findings in preliminary films are described as thickening and fuzziness of the linear markings in 46, evidences of atelectasis in 28, ring shadows in 12, pneumonic shadows (bronchopneumonia or atypical pneumonia) in 19, and no abnormal shadows in 11.

Bronchograms were necessary for positive diagnoses. For introduction of the iodized oil, the author recommends the supraglottic method for general use as being simple and requiring no special apparatus. The lesions were localized as follows: left lower lobe alone, 23; right lower lobe alone, 13; both lower lobes, 12; right middle lobe alone, 2; both lower lobes and right middle lobe, 2; both lower lobes, right middle lobe, and lingula of left upper lobe, 2; right upper lobe alone, 1; lingula of left upper lobe alone, 1; right middle and right lower lobes, 1; left lower and right middle lobes, 1; both lower lobes and lingula of left upper lobe, 1.

Such complications as acute pneumonitis, pulmonary abscess, empyema, pulmonary fibrosis, and emphysema are inevitable in the long-standing cases and may lead to cor pulmonale. Metastatic abscesses to brain, liver, and bones are not uncommon. Amyloidosis is rare.

The author also discusses prophylaxis and medical and surgical treatment. HENRY K. TAYLOR, M.D.

Residual Mustard Gas Bronchitis: Effects of Prolonged Exposure to Low Concentrations of Mustard Gas. Philip Morgenstern, Frank R. Koss, and William W. Alexander. Ann. Int. Med. **26:** 27–40, January 1947.

Mustard vapor, like other irritant gases, produces an inflammatory reaction in the mucosa of the respiratory tract. The severity of the inflammatory process will vary with the concentration of the gas, the length of exposure, and the susceptibility of the individual. But, although the inflammation is most severe in the upper respiratory tract, decreasing in intensity downward, it is the smaller bronchi and bronchioles which tend to show residual pathologic changes due to the accumulation of secondarily infected secretions and necrotic tissues. The "peribronchial thickening" often noted in the basal portions of the lung fields on roentgenograms may well represent small areas of patchy atelectasis. The stage is then set for the development of bronchiectasis.

Fifty-five out of 85 patients suffering from exposure to mustard gas, on whom lipiodol studies were done, showed definite roentgen evidence of bronchiectasis ranging from slight involvement of a few bronchi in one

lower lobe to extensive involvement of as many as four lobes. Roentgenographic findings range all the way from minimal increase in the prominence of the bronchovascular markings to definite peribronchial thickening and patchy basal pneumonitis. A patient may, however, have negative bronchograms and an apparently normal chest film and yet be partially disabled because of a persistent paroxysmal cough, for roentgen studies can show structural changes when they exceed a certain degree but they cannot demonstrate disturbed physiology of the bronchial musculature and mucosa. The roentgenogram, therefore, is of limited value in chronic mustard gas bronchitis as compared to its role in other chest diseases.

Present routine treatment of chronic mustard gas bronchitis consists of postural drainage, high fluid intake, 60 grains of ammonium chloride daily, and removal of the patient from all contact with smoke, fumes, or dust. Steam inhalations are often of value in easing the tight sensation and wheezing in the chest. Most patients feel considerable relief of wheezing and chest tightness for several days or weeks after a lipiodol instillation. Recently good results have been reported with the use of nebulized penicillin.

STEPHEN N. TAGER, M.D.

Surgical Thoracic Tumors in Navy Personnel. Wm. Law Watson and Henry D. Diamond. J. Thoracic Surg. **16:** 1–11, February 1947.

The Naval Hospital in Brooklyn, N. Y., is designated as the regular treatment hospital for neoplastic cases in the Navy serving ships and stations on the Atlantic Coast and in the Ninth Naval District. During a three-year period, 746 cases of neoplastic disease were seen and treated. Thirty-three of these patients had thoracic tumors suitable for surgery, of which 24 were benign and 9 malignant. All the cases were in males, ranging from seventeen to forty-seven years of age. Twenty-three patients had no symptoms and the diagnosis was made by routine chest films. In 5 of these the tumor was malignant.

Of the 33 thoracic tumors, 17 were lung tumors, including 3 carcinomas and 2 mesothelial sarcomas. There were 3 chest wall tumors, of which 2 were malignant, and 13 mediastinal tumors. The authors feel that these figures add weight to the growing impression that all persons should have routine periodic chest radiographs. HAROLD O. PETERSON, M.D.

Carcinoma Simulating Pulmonary Tuberculosis: Differential Diagnosis in the Presymptomatic Stage in Two Cases. Louis E. Siltzbach. Am. Rev. Tuberc. **55:** 170–176, February 1947.

Two cases are reported in which pulmonary neoplasms simulated tuberculosis and the patients were treated for the latter condition for periods of seven and sixteen months, respectively, before the neoplastic nature of the lesions was recognized. In both instances the lesions first appeared as moderately well circumscribed shadows about 2 cm. in diameter. Later the shadows became sharper and more distinct. Increase in size was slow. The difficulty in differentiating between early pulmonary neoplasms and small circumscribed tuberculous infiltrates is emphasized, particularly when the lesion is situated in an upper lobe. Exploratory thoracotomy is suggested when the diagnosis is equivocal. L. W. PAUL, M.D.

Pulmonary Adenomatosis Complicated by Lobar Pneumonia. Carter M. Alexander and Foo Chu, Arch. Path. **43:** 92–101, January 1947.

A patient was hospitalized twice for respiratory disease and died ten days following the second admission. At necropsy the lower lobe of the right lung was large, heavy, and consolidated. Its parenchyma was yellow-pink with a moist, gelatinous cut surface. In the lower lobe of the left lung was a solitary nodule with a yellow, gelatinous cut surface and a fairly firm consistency.

The histologic examination showed the usual picture of a severe pneumonia in the right lower lobe. In many scattered foci in this lobe there were also alveoli containing tall columnar cells covering the alveolar septa in a single layer. The cells were larger than columnar cells of bronchial mucosa. The nuclei were of moderate size, oval, basal in the cell, abundant in chromatin. The cytoplasm was shown to contain droplets of mucin and there was abundant mucin in the tumor-lined alveoli. Many similar foci were also seen in the right upper and middle lobes, as well as in the nodule in the left lower lobe. None of the sections showed the columnar cells which lined the alveoli to be continuous with the bronchiolar epithelium. No invasion of blood or lymphatic vessels and no evidences of metastases were seen. The diagnosis was pulmonary adenomatosis.

The authors have reviewed nine other cases in the literature and conclude that the clinical course was not sufficiently typical to make the diagnosis before pathological study. They believe the tumor in their case was of multicentric origin rather than starting in one place in the lung and spreading to other lobes. They also feel that the tumor is benign but potentially malignant. The prognosis is poor. The resemblance to "jagziekte," an infectious disease of sheep, in which the alveoli are lined with cuboidal and columnar cells is discussed. In the latter, mucin formation is not prominent. The authors believe that the two diseases are unrelated etiologically. (In this connection see also Paul and Ritchie: Radiology **47:** 334, 1946.—ED.)

PAUL W. ROMAN, M.D.

Pulmonary Complications of Dorsal Sympathectomy. Robert C. Pendergrass and Frank F. Allbritten, Jr. Am. J. Roentgenol. **57:** 205–212, February 1947.

The authors describe the complications observed radiographically following preganglionic sympathectomies with excision of the proximal segments of the second and third intercostal nerves and division of the dorsal sympathetic chain distal to the third dorsal ganglion. The operative incision is of considerable depth, exposure is consequently limited, thin-walled veins are numerous, and, postoperatively, a potentially large extrapleural or intrapleural space results from the dissection. Five instances of resection of the fourth rib and one of resection of the second rib, instead of the third, were noted. In 3 patients extrapleural hemothorax developed; in 2, mediastinal emphysema; in 1, massive pneumothorax. Subcutaneous emphysema and small apical fluid levels believed to be due to accumulation of serum or blood, or both, in the extrapleural space, were common postoperative findings.

Routine roentgen examination is recommended following dorsal sympathectomy, with postero-anterior and lateral projections with the Potter-Bucky dia-

phragm or stationary grid. In the differentiation of extrapleural fluid from effusion in the intrapleural space the following points may be helpful: (1) in the erect position, extrapleural fluid does not collect in the costophrenic angle; (2) in the supine position, extrapleural fluid does not disperse as a diffuse shadow, but retains the same contour as in the erect position; and (3) a convex lower and anterior border is seen with the larger fluid collections.

Six illustrative cases are reported.

ELLWOOD W. GODFREY, M.D.

Progressive Scleroderma of the Skin with Cystic Sclerodermal Changes of the Lungs. A. Dostrovsky. Arch. Dermat. & Syph. **55:** 1–11, January 1947.

Progressive scleroderma is a disease that usually affects the skin and underlying musculature. Autopsy reports, however, have shown that internal organs, such as the esophagus, lungs, heart, kidneys, liver, and endocrine glands may also be affected.

The author describes three cases showing that there are characteristic pulmonary changes when the disease affects the lungs. Autopsy reports on two of these cases show that the lungs become cystic in their mid portion and basal areas. There is an increase in fibrous tissue throughout the lungs and a thickening of the blood vessels. There may be adhesions between the lobes to such a degree that they grow firmly together.

The radiographic findings in these cases are in no way characteristic of the disease. There is an increased amount of fibrous tissue similar to that seen in an old hematogenous infection. Some cases may show cystic or cavity-like shadows in the mid and lower portions of the lungs. The apices are not usually affected.

JOSEPH T. DANZER, M.D.

Human Glanders: Report of Six Cases. Calderon Howe and Winston R. Miller. Ann. Int. Med. **26:** 93–115, January 1947.

Six cases of glanders occurring within the space of one year among personnel involved in laboratory research work with *Malleomyces mallei* are reported. The diagnosis was substantiated by a significant and sustained rise in the serum titer of agglutinins for *M. mallei* in 5 cases and by a less marked rise in titer in the sixth case. In 4 cases the complement-fixation test also became positive. The only other striking laboratory finding was a persistent leukopenia and relative lymphocytosis. With recovery, the lymphocytosis tended to subside, and the differential count gradually resumed normal proportions.

The roentgen findings in 4 cases were similar, in that the lesions suggested lung abscess in the early stages, before cavitation and necrosis, being fairly well circumscribed and roughly circular in outline. In another case the lesion was more suggestive of pneumonitis, being somewhat diffuse and infiltrating in character. In one case chest films were negative. In no instance was there roentgen evidence of pleuritis or pleural effusion.

All 6 patients were treated with sulfadiazine because of striking evidence of its efficacy in animals infected experimentally with *M. mallei*. The indications are that that human infection with *M. mallei* is also amenable to sulfadiazine, though no definite conclusions can be drawn from so small a series.

STEPHEN N. TAGER, M.D.

Surgical Treatment of Myasthenia Gravis. O. Theron Clagett and L. M. Eaton. J. Thoracic Surg. **16:** 62–78, February 1947.

This article presents a complete discussion of myasthenia gravis, primarily from the surgical point of view. The authors have studied 191 cases of the disease of which 32 were treated operatively and followed for at least six months thereafter. In 15 cases tumors of the thymus were found. In 17 cases, no tumor was found, but in 16 of these the gland was enlarged.

Before the present study was undertaken, in 1941, no case of a thymic tumor had been unequivocably demonstrated roentgenographically even though all patients had had stereoscopic roentgenograms of the chest. A review of the 191 cases constituting the basis of this paper showed that with the use of fluoroscopy and oblique and lateral views, 30 tumors of the thymus were demonstrable, an incidence of 15.7 per cent. Of the 30 cases in which a definite roentgenologic diagnosis was made, the diagnosis was verified surgically in 17 cases and at necropsy in 5 cases. In 8 cases the diagnosis remained unverified, but in these the roentgenographic evidence was unequivocal. Furthermore, in none of 19 cases in this series in which the results of roentgenologic examination were negative for tumor were tumors found at surgical exploration (18 cases) or at necropsy (1 case). Only one mistake was made: a small tumor was diagnosed radiographically but none was found at operation. It is therefore believed that by careful roentgen examination, practically all thymic tumors in myasthenia gravis can be diagnosed preoperatively.

HAROLD O. PETERSON, M.D.

Congenital Heart Disease with Isolated Inversion of the Abdominal Viscera. Paul Forgacs. Brit. Heart J. **9:** 27–33, January 1947.

Forgacs describes two cases of partial inversion of the viscera, with transposition of the abdominal organs only, the heart retaining its normal position. Both patients showed evidence of congenital heart disease. A search through the literature revealed 12 similar cases. The author believes that this group may represent a distinct entity, and that the paucity of reported cases is due to lack of appreciation and uncritical reviews of these patients. Details of the previously reported cases are furnished.

The 14 cases are discussed, but the author hesitates to estimate the total incidence of congenital heart disease or the relative frequency of the various types of cardiac defect associated with isolated inversion of abdominal viscera. Predominance of transposition of the atria is, however, striking—8 of the 14 cases demonstrating this rare abnormality. Two of the cases had a common atrium supplying both ventricles, and the status of the atria in the 4 remaining cases was indeterminate. It would, therefore, appear that this represents the key defect of the heart, and the associated structural changes develop in order to direct arterial and venous blood to their proper outlets. Transposition of the aorta to the right ventricle and the pulmonary artery to the left ventricle would achieve this effect. All other associated defects are incompatible with normal survival of the affected individual.

The author develops an hypothesis based upon the fact that development of the atria is dependent upon the return flow of venous blood from the viscera and placenta in fetal life. The flow of blood from transposed viscera to a normally placed sinus venosus, or

from viscera in normal position to a dextrocardia, favors transposition of the atria and the development of congenital heart disease as presented in these cases.

LOUIS BERNSTEIN, M.D.

Diagnosis and Treatment of Tracheal and Esophageal Obstruction Due to Congenital Vascular Ring. Richard H. Sweet, Charles W. Findlay, Jr., and Gertrud C. Reyersbach. J. Pediat. **30:** 1–17, January 1947.

Two cases of surgical intervention for double aortic arch are presented. Physical signs characterizing the condition include wheezy respiration and attacks of coughing. The stridor is usually noted at birth and often becomes worse during feeding. In many cases the infant breathes normally while asleep. These signs are aggravated by upper respiratory infections, to which these children are unusually susceptible. Dysphagia increases in severity as a more solid diet is given. Stridor may be more pronounced during deglutition, even without dysphagia.

A postero-anterior roentgenogram of the chest may arouse suspicion of anomalous great vessels because of a widened mediastinal shadow extending mostly to the right. Often the normal aortic knob is not seen on the left. The lateral surface of the barium-filled esophagus is indented by the aortic arch, which carries the major blood load. The defect can occur on either side. There may be forward and lateral displacement of the trachea and esophagus. Narrowing of the trachea at the site of the constricting vascular ring is a prominent feature.

The first patient described by the authors proved at operation to have a right aortic arch arising from th usual location at the base of the heart. This proceeded posteriorly, joining another much smaller vessel behind the esophagus. The latter (the left aortic arch) arose from the right aortic arch above its cardiac origin. Beyond the junction of the two components, the artery followed the normal course of the descending aorta. Other anomalies found were a left innominate artery and a patent ductus arteriosus.

Embryologically this case can be explained by assuming that the right fourth aortic arch persisted and became the main blood conveyor to the descending aorta. The left fourth arch also remained, and thus a permanent vascular ring about the esophagus and trachea was formed.

A right fourth arch was present in the second case also. In this patient the diameter of the vessel was one-eighth that of the aorta. It arose from the ascending aorta above the base of the heart and reunited with the main vessel just below the point where the aortic arch becomes the descending aorta. Another vessel, identified as the right innominate artery, arose at this junction. Thus, a congenital vascular ring was formed by a persistent right fourth arch which connected the ascending and descending aortas.

In the opinion of the authors, surgery is indicated when this congenital anomaly is accompanied by symptoms. Perfect results were obtained in the cases reported.

M. WENDELL DIETZ, M.D.

Changes in the Precordial Electrocardiogram Due to the Position of the Exploring Electrode. Clough Turrill Burnett. Rocky Mountain M. J. **44:** 107–115, February 1947.

This is a rather voluminous article, which ought to be of interest to cardiologists, as the author is systematic, scholarly, and thoughtful in the presentation of his material.

He discusses first the inaccuracy of localization of the cardiac apex by the usual methods of physical examination, citing the fact that when patients appear for cardiograms, there has often been considerable disagreement as to just where the apex should be indicated by a marking. Various authors are quoted to emphasize the disagreement as to the most accurate method of localization of the cardiac apex.

As a check on all of the methods, the author has located it fluoroscopically, having an assistant mark the spot with the tip of a uterine sound, then identify it for others by marking with a colored pencil. Using this as a control, the accuracy of the various other methods was appraised. The diaphragm of the fluoroscope should be narrowed greatly. The upright position, standing or sitting, is preferred.

The author concludes by saying: "Accurate localization of the cardiac apex is difficult or impossible by any method save by roentgen examination.... If this is not done, frequent and at times significant changes in the electrocardiographic curve may result...."

PERCY J. DELANO, M.D.

THE DIGESTIVE SYSTEM

Webs and Constricting Bands in the Upper Esophagus (Sideropenic Dysphagia). Merthyn A. Thomas. Am. J. Roentgenol. **57:** 213–219, February 1947.

Webs and bands of the upper esophagus are said to occur invariably above the suprasternal notch, the favorite location being the postcricoid area (Macmillan: Surg., Gynec. & Obst. **60:** 394, 1935). They are found predominantly in adult women, and from a review of the literature Thomas concludes that the primary cause is a deficiency of iron. The pathological changes in the esophagus, as well as such associated changes as splenomegaly, glossitis, cracking in the corners of the mouth, and koilonychia, are secondary to a hypochromic anemia.

The radiographic demonstration of the constricting bands or webs is accomplished by a somewhat specialized technic. The site of the obstruction may be demonstrated fluoroscopically while the patient swallows a barium capsule. Detailed study by this method is unsatisfactory, however, on account of movement due to choking and gagging occasioned by stoppage of the capsule. Films made with rapid exposure immediately after the patient swallows a large mouthful of barium mixture show the constricting band or web in an otherwise distended esophagus.

The treatment consists of dilatation to relieve the dysphagia and large doses of iron continued over a long period of time. The possibility of a relationship between the epithelial changes found in this syndrome and the development of cancer is noted.

Four case histories are included.

ELLWOOD W. GODFREY, M.D.

Esophageal Atresia in Tracheo-Esophageal Fistula. William E. Ladd and Orvar Swenson. Ann. Surg. **125:** 23–40, January 1947.

Since January 1939, 82 cases of esophageal atresia have been seen at the Children's Hospital, Boston. Four patients were moribund on admission, and 2, with multiple associated anomalies, were operated upon by

other members of the staff. The results in the remaining 76 operated cases are tabulated. The embryology, pathology, clinical findings, and roentgen examination are discussed briefly, the major part of the article being given over to a description of the surgical procedures used and the presentation of 2 unusual and 4 typical cases.

Large, Otherwise Normal Gastric Rugae Simulating Tumor of Stomach. A Report of Three Cases. William E. Ricketts, Joseph B. Kirsner, and Walter Lincoln Palmer. Gastroenterology **8:** 123–130, February 1947.

Three cases, well illustrated with roentgenograms and drawings of the gastroscopic findings, show how a gastric tumor may be simulated by large mucosal folds. In 2 of the cases the insufflation of air into the stomach reduced the mucosal folds to normal size. In the other case the subsidence of peristalsis was followed by a return to normal. There was no gastroscopic evidence of gastritis in any of the cases.

[It might well be pointed out that, when describing the radiological findings, the authors use the words *contraction, peristaltic activity,* and *large mucosal folds,* whereas for the gastroscopic findings they employ the terms *hyperemia, edema, swollen.* There thus seems to be an attempt to keep certain terms for gastroscopy and certain terms for radiology, whereas actually the two overlap and similar terms could be used for similar appearances. S. F. T.] SYDNEY F. THOMAS, M.D.

Restoration of Gastric Motility by Urethane of B-Methyl Choline After Section of the Vagus Nerves for Peptic Ulcer. Thomas E. Machella, Horace H. Hodges, and Stanley H. Lorber. Gastroenterology **8:** 36–51, January 1947.

Two cases are reported in which urethane of B-methyl choline was used to promote peristalsis following vagotomy. It appeared to be most effective when given subcutaneously, but oral and sublingual administration in a slightly higher dosage had considerable effect. The action of the drug was demonstrated roentgenologically and by means of balloon-kymographic records.

SYDNEY F. THOMAS, M.D.

Gastro-Ileostomy, A Rare Surgical Error: Symptoms and X-ray Findings. Charles H. Brown, James R. Colvert, and Brock E. Brush. Gastroenterology **8:** 71–81, January 1947.

The authors found in the literature 23 cases of gastro-ileostomy and to these they add 3 cases of this rare surgical error. Mechanically there are three possibilities when a gastro-ileostomy has been done: (1) The gastro-ileostomy may be so located and so patulous that the barium is literally dumped into the ileum. Since the stoma is so close to the ileocecal valve, the barium is soon in the colon. The resulting clinical features are diarrhea and malnutrition. (2) The stoma may be so located that, when the stomach is full, its tonus and the spasm around the stoma permit very little barium to leave the stomach by that route. Instead, it leaves the stomach by way of a normally functioning pylorus. Subsequently, when the stomach becomes empty and loses some of its tone, the barium, which has now passed through the jejunum into the ileum, may reenter the stomach through the stoma. This would explain the symptoms of nausea and vomiting, with malnutrition and weight loss. (3) There may be a combination of these two mechanisms, part of the barium leaving the stomach through each exit and that which passes through the pylorus partly refilling the stomach sometime later. This would give a combined clinical picture.

The authors' cases illustrate these different mechanisms. In one case all the barium left the stomach by way of a patulous pylorus, only to refill the stomach in five and a half hours. In another case most of the barium left the stomach by way of the stoma, traversed a very short section of ileum to the colon, which was fairly well filled in half an hour. Some of the barium, however, left by way of the pylorus to refill the stomach in three and a half hours. In the remaining case, also, both mechanisms were active.

Refilling of the stomach with barium has not been reported previously. The authors consider it an important diagnostic aid and point out that serial barium films of the whole abdomen should be made whenever a gastro-ileostomy is suspected.

SYDNEY F. THOMAS, M.D.

Post-Bulbar Duodenal Ulcers. Laureano Falla Alvarez and Pedro L. Fariñas. Gastroenterology **8:** 1–13, January 1947.

Duodenal ulcer involving the post-bulbar area is not as uncommon as is usually supposed. This report includes 16 cases discovered in a period of five years. The authors point out that other cases may perhaps have been overlooked because of the difficulty of examining this particular area.

The symptoms may be those of the usual duodenal ulcer or may be atypical. When atypical, the pain may begin suddenly and generally mildly, increasing rapidly in severity. Food relief is not consistent, and when it does occur is more delayed than in typical duodenal ulcer. The most characteristic radiological sign of post-bulbar ulcer is the niche defect, occasionally *en face* but usually located on the inner border just beyond the bulb. The muscosal folds may appear thick and irregular or cushion-shaped, and the margins of the duodenum undulant or irregular.

The relative incidence of post-bulbar ulcer as compared to bulbar ulcer in the authors' experience was about one to seventeen. The average age of their patients was forty-four years, about ten years more than for the usual duodenal ulcer involving the bulb (cap). Bleeding was the most frequent complication, occurring in 37 per cent as contrasted to an incidence of about 12 per cent in bulbar ulcers.

The literature is reviewed and a good bibliography is appended. SYDNEY F. THOMAS, M.D.

Intussusception of Excluded Distal Ileum with Spontaneous Expulsion per Anum of Sequestrated Intussusceptum. Edward O. Finestone. Surgery **21:** 34–42, January 1947.

During the past twenty years, only a small number of cases of spontaneous cure of intussusception by sequestration and extrusion of the invaginated bowel have been reported. Only one case similar to the one here reported is recorded (d'Allaines and Martin: Arch. d. mal. de l'app. digestif **26:** 944, 1936). In that instance, after exclusion of the distal ileum by ileotransverse colostomy, intussusception of the extruded ileum into the cecum occurred, necessitating resection of the gangrenous portion of the ileum.

The author presents a detailed summary of the medical and surgical history of a 48-year-old white woman, first admitted to the hospital in 1940, for nonspecific ileocolitis of two years' duration. Following medical treatment with unsatisfactory results, ileosigmoidostomy was done with division and exclusion of the inflamed distal ileum and cecum. The free edges of the mesentery of the divided ileum were not anchored in any way. During the year following this operation, repeated attacks of small bowel obstruction occurred and were controlled with an indwelling Miller-Abbott tube. Finally, operation revealed an insinuation of a loop of small bowel beneath the free margin of the mesentery of the ileum just proximal to the anastomosis. The obstruction was reduced and the mesentery was sutured to the posterior parietes. A few weeks after this operation, abdominal pain, distention, fever, and a mass in the right lower quadrant appeared. Shortly thereafter, a gangrenous segment of bowel was passed by way of the anus, and was presumed to be the excluded loop of terminal ileum.

Subsequent to this spontaneous cure of intussusception, the patient had an intra-abdominal abscess and wound infection. Later, operation was required for repair of an incisional ventral hernia at the site of the infection, and in 1943 cholecystectomy and common duct drainage were done but adhesions and the location of these incisions prevented operative confirmation of absence of the distal ileum. At last observation the patient was in a good state of health and free of complaints. Roentgenograms made with barium enema before and after ileosigmoidostomy and before and after extrusion of the intussusceptum are reproduced. The last film shows a small outpocketing of the medial aspect of the cecum, which the author believes is all that remains of the distal, excluded portion of the ileum.

It is pointed out that, when ileocolostomy is done for exclusion of inflamed bowel, the divided mesentery and the terminal ileum should be tacked down to prevent intestinal obstruction due to insinuation of bowel behind the proximal mesenteric edge and intussusception of the excluded ileum. J. E. WHITELEATHER, M.D.

Residual Defects After Sprue. A Review of 26 Cases. Robert Drew, Kendal Dixon, and Eric Samuel. Lancet **1:** 129–134, Jan. 25, 1947.

Twenty-six men with sprue, who had been invalided to Great Britain from South-East India (25) and North Africa (1), were investigated by clinical, radiological, and biochemical means. The body-weight, anemia, and appearance of the tongue, together with the number and fat-content of the stools, were the criteria used for assessing the activity of the condition. On this basis, 12 men had completely recovered, 9 showed mild, 4 moderate, and 1 severe signs of sprue. The small bowel was examined roentgenologically by contrast media delivered through a Miller-Abbott tube. Radiologically, 13 men showed no abnormality, this number including 10 who were clinically well; 7 showed mild, 4 moderate, and 2 severe changes in the bowel pattern. Radiologic changes were of four types (1) changes in motility; (2) changes in tonicity; (3) changes in the mucosa; and (4) changes in the colon. Roentgenograms showing each type of change are reproduced. Of the 14 patients investigated biochemically, only 2 showed definite fat-absorption. In this series it was found that clinical and radiological changes persisted for the same length of time and were of equal value in assessing the degree of recovery. Deficiency in fat-absorption was detectable only in patients showing little recovery.

Steatorrhea. Henry T. Ricketts, Samuel N. Maimon, and Kathryn Knowlton. M. Clin. North America **31:** 125–133, January 1947.

Any chronic or intermittent diarrhea characterized by large, frothy stools with a "sour-milk" odor suggests steatorrhea. The suspicion can be strengthened by direct microscopic examination of the feces and confirmed by quantitative determination. In fixing etiology, the first step is a search for pathogenic organisms in the stools, since excessive fat excretion may accompany or follow infectious diarrhea of bacterial or parasitic origin. The next step is a careful roentgen study of the gastro-intestinal tract, *including a plain film of the abdomen* designed to show pancreatic calculi. If they can be demonstrated, the diagnosis is established at once. If none is found, the steatorrhea may be due to (*a*) other pancreatic disease (obstruction of the duct by radiolucent material, cyst, tumor, or inflammation), (*b*) disease of the intestines, mesentery or lymph nodes, or (*c*) "idiopathic" causes (sprue).

A case of steatorrhea associated with pancreatic calculi, pancreatic cyst, and chronic pancreatitis and one of "idiopathic" steatorrhea (sprue) are presented, with the differential diagnosis and treatment in each instance. Three cases of steatorrhea due to miscellaneous causes are discussed.

Volvulus of the Caecum. Ralph H. Gardiner. Brit. M. J. **1:** 83–86, Jan. 18, 1947.

The author, reporting 3 personal cases of volvulus of the cecum, expresses the definite opinion that this condition is far more common than has hitherto been suspected. Non-fixation of the cecum and right half of the colon, the only prerequisite, is estimated to occur in from 15 to 25 per cent of all persons, being slightly more common in females, though the disease is found more often in males, in a ratio of three to one. Partial torsion often occurs in recurrent attacks over a period of years, sometimes culminating in an acute complete torsion, and may be the cause of obscure abdominal pain and discomfort, simulating in some cases subacute appendicitis. The onset of symptoms may be classified as acute, subacute, and chronic. In the latter two forms, distention is generally gross.

A survey film of the abdomen is of inestimable value and is diagnostic in most cases; the greatly dilated cecum casts a clear shadow, which may, however, be mistaken for gastric dilatation due to pyloric stenosis. The case history should exclude this error, which may arise in cases of slow onset, but a small quantity of barium by mouth will indicate the position of the stomach higher up. A barium enema is rarely necessary for diagnosis.

The treatment is surgical, dealing with the condition of the gut found at operation—if viable, by derotation and fixation; if gangrenous, by right hemicolectomy.

ELLWOOD W. GODFREY, M.D.

Interesting X-Ray Findings in a Case of Acute Fulminating Ulcerative Colitis. Emil Jobb and Arthur Finkelstein. Gastroenterology **8:** 213–220, February 1947.

The authors report a case presenting an interesting clinical picture of partial bowel obstruction associated

with signs of peritoneal irritation indicative of impending perforation, and the dramatic roentgen demonstration of large ulcerations of the entire colon. Because of the fear of impending complete obstruction which might have necessitated laparotomy, a barium enema was cautiously given to obtain additional information. This roentgen study demonstrated the absence of any obstructive lesion and thus justified the continuation of conservative therapy despite the marked colonic distention. The visualization of unusually extensive ulcers provided an adequate explanation for the severity of the clinical findings. This case illustrates how extensive the disease process in the colon may be in acute ulcerative colitis and still be followed by complete healing within a relatively short time—five months.

A Contribution to the Radiologic Diagnosis of Internal Biliary Fistulas. H. Plattner. J. de radiol. et d'électrol. **27:** 505–509, 1946.

The author includes in this discussion the most frequently encountered internal biliary fistula, namely, that produced by ulceration of a gallstone through the gallbladder or common duct into the duodenum, the much less frequent perforation of a duodenal ulcer to involve the biliary tract, and third, a traumatic change in the sphincter of Oddi, resulting in its incontinence. He covers, also, the operatively produced fistulas in which it has been elected to suture the gallbladder to the duodenum.

The illustrations are typical, showing the familiar picture of the biliary tree outlined by barium following a barium meal. There is also a discussion of the outlining of the larger bile ducts by air, which may sometimes be noted in plain films. This phenomenon received abundant emphasis from Rigler some time ago, when he pointed out the need for searching for such bile duct outlines in a scout film for intestinal obstruction.

Although the author does not discuss the physical well-being of the patients at great length, this phase of the subject merits a word. If the communication involves only the gallbladder, the symptoms are not apt to be marked, nor is there likely to be a demonstration of the bile ducts by air or barium; but when the communication involves the common duct, the liver receives a liberal dousing with food contents after every meal. Nevertheless, these patients do not seem to show evidence of much biliary infection, and some of them have been followed in various clinics for as long as fifteen to twenty years, with internal biliary fistulas unrepaired.

At the gastro-intestinal end of the fistula, the duodenum is most frequently involved; the stomach and colon rarely.

The operative mortality is about 10 per cent.

PERCY J. DELANO, M.D.

THE MUSCULOSKELETAL SYSTEM

Hypermobility of Bones Due to "Overlengthened" Capsular and Ligamentous Tissues: A Cause for Recurrent Inter-articular Effusions. Charles J. Sutro. Surgery **21:** 67–76, January 1947.

Five patients with recurrent effusions of the ankles or knees, not associated with known external local trauma, exhibited also an abnormal degree of mobility of many joints, due apparently to excessive length of the ligaments which stabilize and limit joint motion. This laxity permits repeated damage to the capsular and ligamentous structures of the joints as a result of minor missteps or subclinical trauma during routine physical activities.

The author describes in detail the range of motion observed in his 5 patients and illustrates his text with photographs and roentgenograms. Practically every joint of the upper and lower extremities and the spine were involved, permitting grotesque positions without discomfort to the patient. Radiographic studies confirmed the abnormal range of movement demonstrated on physical examination.

Treatment of recurrent effusions in such patients should first be conservative, with bed rest and application of cold or warm compresses to the painful part. Traction relieves associated spasm; aspiration is done only if the effusion is large. After cessation of pain, non-weight-bearing exercises strengthen the muscles. An elastic bandage may be applied about the joint when effusion has subsided. Permanent use of elastic supports and concomitant muscle training are suggested to prevent further accidents to the unstable joints.

No pathological material is available to determine whether these ligamentous structures contain abnormal amounts of elastic tissue, and the assumption is that the mobility is attributable solely to overlengthening, due perhaps to a relative disproportion in rate of growth of adjacent bones and ligaments.

Hypermobility may be a cause of low back pain, cervical rib syndrome, and flat feet, and a basis for recurrent subluxation of the intercarpal region, humeral head, or patella. Surgical intervention is indicated in instances of recurrent, protracted, disabling, frank subluxations of the astragalus, carpal bones, humeral head, or patella, with or without hypermobility.

J. E. WHITELEATHER, M.D.

Marble Bone Disease. A Study of Osteogenesis. Carla Zawisch. Arch. Path. **43:** 55–75, January 1947.

This is a study of a comparatively rare congenital bone disease known as marble bones, Albers-Schönberg disease or osteopetrosis. The chief histologic characteristics are "an extremely thick cortex of the long and short bones and a narrow marrow cavity filled to a great extent with medullary bone of abnormal structure."

A case, described elsewhere in the literature (Windholz: Ztschr. f. Kinderh. **51:** 708, 1931) served for the present study. The infant had died (at the age of thirteen months) since the previous report and the bones were now available for study. Cross sections through the middle of the femoral diaphysis showed the entire history of this bone. The usual normal development of ossification is described in detail by the author and compared with what must have happened in this case. The interpretation of the course of events is based on the microscopic findings observed in cross sections of the femur and ribs. In the femur, the diameter of the marrow cavity corresponded to that of a fetus of five and a half months instead of that of a child thirteen months old. The cavity was bordered by a thick cement line no which endosteal bone had been deposited. Resorption had stopped at the thick cement line.

The findings indicated to the author that marble bone disease starts at the beginning of the second period of bone formation. From then on, pathologic bone tissue is deposited. Resorption of the stratum from within does not take place, and the cortex remains unusually thick. Internal resorption cannot make up for this failure and the entire bone-forming process re-

mains disrupted. Study of the ribs showed that endosteal ossification undergoes the same pathologic development as the cortical.

The author believes the evidence favors an etiology on a basis of a general failure of the fetal bone-forming blastema, which becomes evident whenever the bone enters its second period.

The x-ray findings are explained on the basis of the histologic findings. Clubbing of the ends of the long bones, increased density of all of the bones, and transverse and horizontal bands of increased and decreased density are seen. The clubbing is due to the greater rate of growth at the ends of the long bones. The rate of growth is greater at the proximal end of the humerus and at the distal end of the femur.

The density of the bones is due to the greater amount of calcium deposited in them. The scarcity of fibrils in marble bones, the relatively greater amount of binding substance, and the hyperplasia of chondroid bone and basophilic inclusions increase the absolute amount of calcium.

The transverse bands of greater and lesser density are an expression of the intensity of longitudinal growth, osteoblastic production, and osteoclastic resorption. The longitudinal bands are explained by periodic remissions and recrudescences of the pathologic deposition of bone and by periodic recurrences of widespread resorption. These outbursts of resorption even produce osteoporosis, at times leading to fractures of the bones.

Microscopic findings from a number of cases from the literature are summarized, and references are supplied.

STANLEY H. MACHT, M.D.

Sclerosing Osteomyelitis of Garré, with Report of a Case. Harold A. Lyons. U. S. Nav. M. Bull. **47:** 83–89, January–February 1947.

This is the report of a case that was not diagnosed until persistence of symptoms led to an exploratory operation on the forearm, though, as the author states, the localized pain, tenderness, x-ray picture, and absence of constitutional symptoms and of significant laboratory findings should have suggested the true nature of the condition. At operation, osteomyelitis was discovered and the area was rongeured down to the depth of the medullary cavity, with a good symptomatic result. The pathological examination disclosed sclerotic bone with some mild surrounding inflammatory reaction, consistent with a diagnosis of chronic sclerosing osteomyelitis. Retrospective examination of the roentgenograms, which had been regarded as normal, revealed a slight area of irregularity on the interosseous aspect of the proximal portion of the radius and the thickened sclerotic bone was then outlined.

The roentgen appearance of chronic sclerosing osteomyelitis is typical—increased density with a narrowing of the marrow canal. Ewing's endothelioma and osteogenic sarcoma are easily differentiated from this condition. Paget's disease may be confusing, but is usually multiple, with a greater central density and an increase in serum phosphatase. Syphilis is excluded by the absence of a history of infection and a negative serologic test. Furthermore syphilitic periostitis usually extends over a larger area than was involved in the case here recorded. The other two entities to be considered in the differential diagnosis are osteoid osteoma and Brodie's intracortical abscess.

SYDNEY F. THOMAS, M.D.

A Case of Hypertrophic Osteoarthropathy. W. B. Ayre. Canad. M. A. J. **56:** 71–73, January 1947.

Ayre describes the case of a 57-year-old German prisoner of war in whom all the classical features of hypertrophic osteoarthropathy developed during an eight-month period. X-ray studies revealed a slowly growing mediastinal tumor that responded to roentgen therapy. Early changes in the right wrist were described as "irregularities of contour and thickening of the periosteum on the lower end of the radius." The presenting symptoms at the first admission were swelling of the ankles, pain in the right wrist, and moderate cough with some sputum. Clubbing of the fingers developed in the space of one month after hospitalization. Symptomatic improvement followed roentgen therapy and some regression of the clubbing and soft tissue swelling in the ankles was observed. However, five months later marked hypertrophic changes had occurred—clubbing, soft-tissue changes, large nails with hyperemic beds, deep palmar creases, and enlarged wrists. Comparable changes were found in the lower extremities. The x-ray films of the right wrist revealed a heavy layer of newly formed subperiosteal bone enveloping the distal ulna and radius, with irregular subperiosteal proliferation along the metacarpal shafts and proximal two rows of phalanges. Changes of similar nature were found in all the bones of the upper and lower extremities with the exception of the terminal phalanges, carpals, tarsals, and bones of the pelvic girdle.

Historically the association of pulmonary and cardiac disease with bony and soft-tissue changes was first recognized by Bamberger in 1889, and a detailed description was given by Marie in 1890. He labeled the condition "pulmonary hypertrophic osteoarthropathy."

Ayre discusses the etiology. The commonest visceral lesions are pulmonary, either chronic inflammatory or neoplastic, but also there are definite associations with cardiac, hepatic, and gastro-intestinal diseases of a chronic nature. The changes are more common in males and can occur at any age.

The rapid development of the osteoarthritic changes in this case are unusual, for bony manifestations are not usually pronounced for two or three years. The primary disease process was virtually quiescent during the eight months of observation. The mechanism of the development of the hypertrophic changes could not be explained. No causal relationships between the primary disease and the secondary osseous changes could be established. WILLIS E. MANGES, M.D.

A Rare Osteo-arthropathic Syndrome: Radiologic Considerations. Franco Fossati. Radiol. med. (Milan) **33:** 1–14, January 1947.

The author describes a case of a generalized condition of the bones and joints characterized by multiple bony ankylosis of the hips, elbows, knees, wrists, and ankles, accompanied by atrophy and resorption of the distal ends of metacarpals and metatarsals and of the proximal ends of the humeri, radii, and ulnae. The condition developed over a period of many years, and at the age of forty-four the patient was completely incapacitated. Excellent roentgenograms of the case are presented, the literature is reviewed, and the conclusion is reached that this case cannot be fitted into any of the known diseases of the bones and joints.

CESARE GIANTURCO, M.D.

Infantile Cortical Hyperostoses: Report of a Case. D. D. Dickson, C. A. Luckey, and N. H. Logan. J. Bone & Joint Surg. **29:** 224–226, January 1947.

A two-month-old female infant in July 1945 showed soft-tissue swelling over the right scapula, extending into the axilla, with duskiness of the skin over that region. A roentgenogram in September 1945 showed moderate bony overgrowth of the right scapula and later that same month the reaction was shown to have increased, with involvement of the mandible also. Re-examination in October showed considerable extension of the process in the scapula and involvement of the clavicle. Biopsy at this time showed inflammatory change in the muscle. In November the reaction subsided and by April 1946 the bone appeared normal. No definite indication as to etiology is suggested.

JOHN B. MCANENY, M.D.

Syringomyelia, Morvan's Syndrome. Edward B. Holley. J. Pediat. **30:** 96–101, January 1947.

A case of Morvan's syndrome occurring in a boy of two years and four months is reported. This has been described as a chronic form of syringomyelia characterized chiefly by trophic changes in bones, joints, and skin. The author's patient is believed to be the youngest recorded with this condition. The literature is reviewed, and the 21 cases of the syndrome previously reported are summarized.

Tuberculous Dactylitis in the Adult. A. L. Umansky, P. T. Schlesinger, and B. B. Greenberg. Arch. Surg. **54:** 67–78, January 1947.

The authors report a case of tuberculous dactylitis in a 19-year-old Negro male and discuss the differences between adult and childhood forms of this disease. In both age groups the first sign is an elevation of the periosteum with a linear deposit of bone along the diaphysis. An indefinite irregularity of the cortex next appears, and soft-tissue swelling soon develops. In the child the periosteal reaction is intense, with thickening and expansion of the cortex; the original shaft may be seen enclosed in the new bone. Gradually, however, the shaft is destroyed and finally separates as a sequestrum and is absorbed. Pus and sinus tracts form at this time. In the adult, periosteal reaction is lacking. The initial periostitis is replaced by a large area of rarefaction, with absorption of both the fine cancellous and the compact cortical bone. Sclerosis of the neighboring trabeculae may be present. The bone thickens and has a honeycombed appearance. Pathologic fracture often occurs at this stage; at first there is absorption of bone, later callus appears, and in the end further destruction occurs with debris extending into the soft tissues. The remaining shaft is widened and sclerotic, but shows no large sequestrum, involucrum, or fistula formation. The medullary cavity is almost obliterated.

Differentiation from syphilis, enchondroma, malignant tumor, sarcoidosis, coccidioidomycosis, leprosy, and yaws must be made; biopsy is the most reliable guide. Treatment by immobilization and general measures to combat the tuberculous infection usually leads to a good result in childhood and, if operation is indicated, a subperiosteal resection or curettage with or without bone graft often suffices. In adults the prognosis is bad, since disability and recurrent fracture are the rule; amputation proximal to the metacarpophalangeal joint is advised.

Roentgenograms are reproduced showing the progress of the condition over a period of about two years in the authors' case. Amputation was done, with a good result.

LEWIS G. JACOBS, M.D.

Ewing's Sarcoma of Bone. Louis Lichtenstein and Henry L. Jaffe. Am. J. Path. **23:** 43–77, January 1947.

This study, based on 17 cases, 5 of which were autopsied, supports the existence, among the primary malignant tumors appearing in bones, of a tumor entity to which, because of Ewing's pioneer effort to single it out, the name of Ewing's sarcoma should be applied. Beyond the fact that it is a specific malignant tumor primary in bones, and that its cells show no osteogenic potentialities, there is still much to be learned in respect to its histogenesis. Study of the cytologic patterns in this series yields no support for Ewing's contention that the neoplastic cells are derived from capillary or vascular (or perivascular) endothelium. The authors favor a derivation, as suggested by Oberling, from the supporting framework (the reticular tissue) of the bone marrow, a framework which can be regarded as a mesenchymal or primitive form of connective tissue. In viable neoplastic tissue, well fixed and well stained, the type cell is found to have an ill-defined cell border, little cytoplasm, and a fairly large round or oval nucleus showing scattered chromatin.

This series of cases emphasizes the difficulty in making a diagnosis of Ewing's sarcoma by roentgen examination alone. The bone lesion producing the complaints which led the patient to the hospital was often the only lesion discernible even when the entire skeleton was x-rayed on admission. If the amount of bone involvement in the presenting lesion roentgenologically is still small and no lesions are found elsewhere, the picture may be misconstrued as an inflammatory lesion. In most instances, however, the picture suggests a malignant tumor, although its exact nature is often misinterpreted.

The only fairly consistent roentgen finding is evidence of lysis of bone, by itself a rather nondescript feature. Thus in some cases the presenting lesion may appear merely as a small zone of mottled rarefaction reflecting destruction of the spongiosa and, to a lesser degree, of the overlying cortex, associated with what is as yet only a trace of periosteal new bone apposition in reaction to the neoplastic tissue which has penetrated beyond the cortex. This picture (which may also include some areas of condensation) is very likely to suggest an inflammatory lesion (pyogenic or tuberculous osteomyelitis) rather than a tumor, but within a month or so the roentgenogram shows rapid extension of the pathologic area within and beyond the bone, now strongly supporting a diagnosis of a malignant tumor. Although the film still shows only a relatively small area of bone destruction, this cannot be taken as indicating the actual extent of involvement of the bone, the marrow spaces of which may already be riddled by neoplastic tissue.

When the initial roentgenogram shows rather clearly that the lesion is a malignant tumor, a large area of bone destruction, often with a large overlying soft-tissue mass, is evident. The affected area in the bone may show distention of its outline but, if present, this is not pronounced. However, the affected area appears irregularly rarefied and mottled from the presence of smaller or larger foci of relative radiolucency and shows disruption of the cortical outline over a variable region.

The reactive deposition of new bone by the periosteum, where the neoplastic tissue is penetrating the cortex, is certainly not conspicuous. When Ewing's sarcoma involves bones other than long bones, evidence of periosteal new bone apposition, although not uncommon, is not a striking finding.

When the Ewing's sarcoma is located in the shaft of a long bone, the concentric onion-skin layers of periosteal new bone of a laminated pattern held to be so characteristic of the roentgenologic appearance of this tumor are commonly not observed. Rather, a substantial portion of the shaft may show irregular mottled rarefaction, perhaps with complete absence of significant periosteal bone apposition.

Additional lesions found roentgenographically on admission or subsequently, like the presenting lesion, show evidence of lysis of bone. They appear first as rather faint, slightly mottled areas of rarefaction. As the resorption of the bone increases, the small, multiple, roundish foci of rarefaction become more distinct and may merge into larger, more clear-cut areas of radiolucency. In flat bones, such as those of the skull or the ilium, multiple, clear-cut, punched-out areas of rarefaction may appear in consequence of lytic destruction of the spongiosa and overlying cortex. Even a neoplastic fracture of a long bone from destructive resorption may become manifest. The actual extent of involvement of the skeleton at any one time is never adequately reflected roentgenologically.

A diagnosis of Ewing's sarcoma on the basis of biopsy should not be made without giving consideration to the possibility that one may be dealing with a sympathetic neuroblastoma or an anaplastic carcinoma metastatic to the affected bone. Such alternative possibilities as primary reticulum-cell sarcoma of bone, Hodgkin's disease, malignant lymphoma, and even myeloma must also be eliminated.

Ewing's sarcoma has a most serious prognosis, all the patients in the authors' series having died. Radiation therapy alone, while often having a remarkable palliative local effect for some time, offers as yet but little hope so far as the ultimate issue is concerned. The combination of radiation therapy and surgery in favorable cases would seem to be more promising, but has not yet received sufficient trial.

Sickle Cell Anemia, Case Report with Unusual Roentgen Findings. Ernest Kraft and Giuseppe Bertel. Am. J. Roentgenol. **57:** 224–231, February 1947.

A case of sickle-cell anemia observed in a forty-three-year old, colored male is reported. Only a few cases have been reported at so advanced an age. The radiographic changes consisted in demineralization with coarse and irregular trabeculation of the flat bones; biconcavity of the vertebral bodies with trabecular coarsening and porotic areas, along with some coarse trabeculation and splotchy osteoporosis of the long bones of the lower extremities. The skeletal changes in older patients, as exemplified by the present case, are different from those seen in early life. In childhood there are usually medullary widening and cortical thinning of tubular bones, with possible regression following a crisis. Later in life, there are thickening of cortical bone and sclerosis of cancellous bone, coarsened trabeculae being intermingled with splotchy osteoporotic areas. The skull is the site of the most frequent changes. Early in life there are thickening of the outer table and obliteration of the diploic spaces. Fine vertical striations with a "hair-on-end" appearance are seen within and beyond the outer table after the fifth year of life. At a later age the striae are no longer seen, and lamellated periosteal new bone formations are found instead.

The question of pathogenesis remains unanswered, as the Rh factor, which now plays such an important role in erythroblastic anemia, has not yet been determined in the survey of families with sickle-cell anemia. So far, sickle-cell anemia like target-cell [erythroblastic] anemia is still considered an entity, being slightly different from the other congenital blood dyscrasias. ELLWOOD W. GODFREY, M.D.

Anterior Vertebral Wedging—Frequency and Significance. Gilbert H. Fletcher. Am. J. Roentgenol **57:** 232–238, February 1947.

The author approaches the problem of anterior vertebral wedging from the statistical standpoint. From lateral roentgenograms of the dorsal and lumbar spine, the height of the anterior and posterior aspects of 3,836 vertebrae were measured, and on the basis of these measurements an index of wedging was determined by dividing the height of the posterior aspect of the vertebra by the height of the anterior aspect. For each vertebra the mean index of wedging thus determined and the standard deviation were calculated, and these figures are presented in tabular form. In another table are listed indexes of wedging occurring in 15, 10, and 5 per cent of the vertebrae measured. The figures for the 5 per cent group are held to represent the upper limit of normal, though an index in excess of these is not necessarily abnormal—oaly, on the basis of rarity, probably so. The author concludes that uncomplicated wedging, *i.e.*, symmetrical wedging without the association of other deformities, within the limits established in the table, is of rather common occurrence and consequently has no clinical significance. With this finding alone one cannot make the diagnosis of a former fracture despite the history of a back injury. In addition, the comparison of the distribution of the index of wedging between groups with backache and without seems to indicate that there is no correlation between uncomplicated wedging and that complaint.

ELLWOOD W. GODFREY, M.D.

Extraspinal Lumbar Meningocele. Robert C. Pendergrass, A. Earl Walker, and John P. Bond. J. Neurosurg. **4:** 80–86, January 1947.

Extraspinal meningoceles in the upper lumbar or thoracic region are a great rarity. The authors present a case in a 32-year-old Negro complaining of pain in the back and headache upon rapid change of position. On the left side of the back, extending from the 12th dorsal vertebra to the 4th lumbar vertebra, was a large fluctuant, slightly tender mass. On coughing, the mass distended. Neurological findings were essentially normal. Roentgenograms revealed an absence of the spinous processes of the 11th and 12th thoracic vertebrae and of the left transverse processes of the 1st, 2nd, 3rd, and 4th lumbar vertebrae. The tips of these tranverse processes were visualized in the flank at the outer aspect of the mass. In a lumbar myelogram, the canal appeared to be normal until the 12th interspace, at which point the pantopaque was seen to pass from the left side of the canal through an opening into the large

mass. A diagnosis of extraspinal lumbar meningocele was made. Surgical exposure of the meningocele with an attempt to close the neck was unsuccessful. A partial hemilaminectomy with ligation of the neck of the sac passing through the intervertebral foramen effected a cure.

In this case, the paraspinal lumbar meningocele in all probability was the result of a congenital abnormality of the spine. The localization of the communication between the meningocele and the spinal subarachnoid space by pantopaque myelography made it possible to ligate the neck of the sac through a hemilaminectomy of only two vertebrae. Adequate treatment of such a condition appears to be the obliteration of the communication between the subarachnoid space and the sac. The fluid in the cyst seemed to be more the result of the passage of spinal fluid from the lumbar subarachnoid space into the sac than to the fluid secreted by the sac wall. The patient's complaint of postural headache was the result of rapid changes of intracranial pressure. The mechanism in this instance was probably very similar to that encountered in patients having a large defect of the skull, in whom sudden changes in posture induce headache and vertigo.

Painful, Non-Suppurative, Localized Sclerosis of the Long Bones, with a Report of Two Cases. William Mackenzie. J. Bone & Joint Surg. **29:** 49–58, January 1947.

The author reviews the outstanding contributions to the literature on sclerosing non-suppurative localized lesions in the long bones from the time of Garré down to and including the work of Jaffe and Lichtenstein.

The first of his two cases is that of an eleven-year-old girl with a painful swelling along the medial aspect of the left femoral shaft. This grew larger and more dense. The bone was explored and deeply guttered without discovery of any pus or cavity or sequestrum. Bacteriologic examination was negative and histologic examination showed dense lamnated bone without evidence of inflammatory cell infiltration.

The second case reported is that of a fourteen-year-old boy with enlargement of the middle of the shaft of the left tibia. Early examination by x-ray showed chronic osteitis. Two months later dense cortical sclerosis was seen, within which there was a radiolucent area. Diagnosis of osteoid osteoma was made. Eight months after the original complaint, a large block of bone was removed from the tibia. Histologic examination of this specimen revealed findings that resembled osteoid osteoma as described by Jaffe and Lichtenstein.

"No positive opinion is expressed regarding the essential nature and cause of the bone lesions in these two cases." JOHN B. MCANENY, M.D.

Pathology of Ununited Fractures of the Neck of the Femur. Mary S. Sherman and D. B. Phemister. J. Bone & Joint Surg. **29:** 19–40, January 1947.

This paper is a review of the pathologic changes seen following ununited fracture of the femoral head. The principal factors which determine union or non-union are the extent of the injury, the presence or absence of impaction, accuracy of reduction and fixation, survival or death of the femoral head, and the fact that no peripheral callus is formed. It has been found that pathological changes in the hip joint are rare if the head lives. Its survival depends upon the blood supply. The blood supply to the femoral head is through the anterior and posterior circumflex arteries and through the ligamentum teres. The femoral head fragment dies if the neck and capsule are completely severed and the round ligament carries no blood supply. In non-union, but with viable head, atrophy will take place but will be equal in both fragments. The head never collapses and the articular cartilage is well preserved. In such cases, union usually follows operative procedure and degenerative arthritis rarely follows.

Femoral neck fracture following irradiation has been studied, showing osteoporosis, sclerosis of the vessel, and lack of osteogenesis throughout the fracture area. From roentgenographic appearances, it is believed that the head always remains alive. With death of the femoral head, atrophy of disuse cannot occur, but atrophy of the surrounding bone proceeds, so that the unaltered femoral head stands out as relatively more dense than the distal fragment. The articular cartilage becomes replaced by imperfect fibrocartilage with subsequent osteo-arthritis of the hip joint.

In aseptic necrosis of the femoral head, pathological fracture is prone to occur between the junction of the living and dead bone. Degenerative arthritis is usually present in necrosis of the head with non-union, but is rarely severe in old cases of necrosis with bony union. With non-union there is usually no collapse of a necrotic head; but, if union occurs and weight is borne, collapse may be expected. Open reduction and fixation of a necrotic head may be followed by bony union and a good functional result may occur, but degenerative arthritis usually follows in later years.

JOHN B. MCANENY, M.D.

Primary Congenital Subluxation of the Hip. Jacques Leveuf. J. Bone & Joint Surg. **29:** 149–162, January 1947.

French literature distinguishes between luxation and subluxation of the hip. Subluxation differs from true luxation in that the femoral head remains in contact with a more or less deformed acetabulum. Arthrography will help distinguish subluxation from luxation without difficulty, even in young children. The prognosis in primary subluxation is grave in most cases because of unsatisfactory reduction and the possibility of resulting osteoarthritis of the hip joint.

In subluxation, the limbus is forced upward and inward toward the iliac fossa; in luxation the limbus is forced downward and inward toward the acetabulum. These changes are best seen in arthrograms. The acetabulum in subluxation shows compression and atrophy of the cartilaginous roof, probably due to the force of the femoral head against it. In luxation, on the other hand, the roof and limbus are forced toward the acetabular cavity and the limbus appears hypertrophied, producing an "hourglass contraction." The worn down or shallow acetabulum is believed to be characteristic of subluxation and not of luxation.

The femoral head in subluxation is enlarged and flattened transversely. In luxation it retains its regular contour for a long time. The articular capsule in subluxation is never interposed between the femoral head and acetabulum and the round ligament is practically always absent. In luxation, on the other hand, the capsule is usually interposed, especially at the lower portion of the cavity. The round ligament is present in about one-third of the cases and may even be hypertrophied.

The femoral neck in subluxation is often of the valgus type, measuring 150 to 155 degrees, and anteversion is frequently present. In luxation, however, no valgus is present and anteversion is only exceptionally encountered.

The author presents a general discussion of the treatment of these two conditions and their complications. Numerous fine reproductions accompany this article.

JOHN B. MCANENY, M.D.

Complications of Fractures of the Neck of the Femur. H. B. Boyd and I. L. George. J. Bone & Joint Surg. **29:** 13–18, January 1947.

Three hundred cases of fracture of the femoral neck were reviewed to determine the complications of this injury. The overall mortality was 9.3 per cent. In 141 cases followed for over a year, bony union took place in 122, or 86.5 per cent, with failure of union in 19, or 13.5 per cent. The majority of patients should be followed for at least one year to determine definitely whether bony union will occur. Occasionally, union will occur after a year. In 10 fractures, poor reduction, inadequate mechanical fixation, premature removal of the nail, or a combination of these factors contributed to non-union. The remaining 9 were satisfactorily reduced and fixed, but non-union nevertheless occurred. In 2 of these cases Paget's disease was present in the head and neck of the femur.

Aseptic necrosis of the femoral head occurred in about 33.6 per cent of patients and was demonstrated within two years of the fracture. Arthritic change in the joint was demonstrated in 33.6 per cent of the patients. Aseptic necrosis and arthritic change occurred coincidentally in some instances.

Final analysis of this group of patients shows that a mortality of about 9.3 per cent may be expected in fractures of the femoral neck; poor end-result in 28.1 per cent, which includes ununited fracture and severe arthritic change; fair end-result in 19 per cent; and good end-result in 43.6 per cent

JOHN B. MCANNEY, M.D.

Fracture-Dislocation of the Ankle with Fixed Displacement of the Fibula Behind the Tibia. David M. Bosworth. J. Bone & Joint Surg. **29:** 130–135, January 1947.

In December 1944, the author encountered a fracture-dislocation of the ankle in which attempt at closed reduction produced a poor result with failure to maintain reduction. Exploratory operation was done, at which time it was found that the proximal portion of the fibula had been displaced behind the tibia and was caught back of the posterolateral ridge of that bone. It required considerable force to separate and pry the fibula loose from the ridge of the tibia but, after this, reduction of the fracture-dislocation was easily secured. Several additional cases were later encountered in which this same situation was found.

Roentgenographically the posterior location of the proximal fibular fragment can usually be demonstrated, especially in the lateral view, if this condition is watched for and expected in fracture-dislocation of the ankle. Open reduction is necessary, and extreme force is required to separate the proximal fibular fragment from the tibia.

JOHN B. MCANENY, M.D.

GYNECOLOGY AND OBSTETRICS

Recognition of Midpelvic Contraction. William C. Eller and William F. Mengert. Am. J. Obst. & Gynec. **53:** 252–258, February 1947.

Midpelvic contraction may be recognized more frequently, in the authors' opinion, if roentgen mensuration is employed in the presence of anyone of the following:

A. History
   1. Difficult labor, especially midforceps delivery
   2. Unexplained stillbirth
B. Palpation
   1. Prominent ischial spines
   2. Sacral deformity, especially forward angulation
C. Manual mensuration
   1. Inlet
      a. Ability to touch sacral promontory on vaginal examination
      b. External measurements below average, *i.e.*, interspinous 23 cm. or less, intercristal 26 cm. or less, external conjugate 17 cm. or less
   2. Outlet
      a. Bisischial 8.5 cm. or less
      b. Sum of bisischial and posterior sagittal 15.0 cm. or less
D. Non-engagement of fetal head at term in a primigravida

Hand in hand with a high index of suspicion of midpelvic contraction, and equally important to the obstetrician, is the conviction, based on office methods, that a given pelvis is normal. With average inlet measurements (intercristal 29 cm., interspinous 26 cm., internal conjugate 20 cm.), inability to touch the sacral promontory on vaginal examination, average outlet measurements (bisischial 9.5 cm. +), and no palpatory findings or obvious history as enumerated above, the obstetrician is justified in concluding that no serious mid-plane contraction exists. In such patients roentgenologic mensuration is unnecessary.

Oil Embolism Following Hysterosalpingography. Francis M. Ingersoll and Laurence L. Robbins. Am. J. Obst. & Gynec. **53:** 307–311, February 1947.

The purpose of this report is to record another instance of oil embolism, a serious complication, following hysterosalpingography. The literature on the subject is reviewed by the authors and a fatal case is mentioned (Gajzágó: Zentralbl. f. Gynäk. **55:** 543, 1931). The case reported is that of a 43-year-old woman with oil emboli to the lungs following the injection of 8 c.c. of iodized oil one day following cessation of the menstrual period. The initial uterosalpingogram showed oil in the pelvic veins. Symptoms developed on the day following the injection of the oil and roentgenograms of the chest showed patchy areas of increased density consistent with infarcts. The patient had a slight elevation of temperature for four days, following which it returned to normal. There was no recurrence of pulmonary symptoms, and films obtained just before the patient's discharge from the hospital showed considerable improvement in the appearance of the chest.

Several precautionary measures are suggested by this case. Uterosalpingography should not be done until

eight to ten days following operation on the uterus or following the cessation of menstruation. After the injection of 2 c.c. of oil a film should be taken to determine whether any oil has entered the pelvic veins. Care should be taken to use a blunt-tipped cannula, thus causing as little direct trauma to the endometrium as possible. It is quite important that close co-operation between the roentgenologist and gynecologist be maintained in order to prevent intravasation of oil into the uterine vascular channels. MORRIS IVKER, M.D.

Uterosalpingography: Report of a Fatality. Arthur M. Faris and Allen McMurrey. Texas State M. J. **42:** 592–597, February 1947.

The authors present a series of illustrations demonstrating the usefulness of uterosalpingography. They use lipoiodine in preference to any of the heavier oils, as lipiodol, skiodan-acacia, etc., because of its more rapid absorption and less irritative properties. The procedure should not, however, be considered entirely harmless, and certain precautions are suggested in its performance. The contrast medium should be injected slowly and the amount limited to the minimum necessary to demonstrate the pathologic condition, usually 5 to 6 c.c. Anesthesia is rarely indicated and should be avoided.

A fatality following uterosalpingography occurred in the experience of one of the authors. The patient was given light cyclopropane anesthesia, because of pain associated with the procedure on an earlier occasion, and 12 c.c. of lipoiodine were injected readily. Stereoscopic roentgenograms were taken and the cannula through which the injection was made was removed. Death ensued within fifteen minutes. The films of the uterus and surrounding area showed the filling of venous plexuses bilaterally with the opaque medium. Its intravenous course is clearly evident in the reproductions.

The authors believe that the intravasation of the medium into the veins was probably the result of injury to the cervical canal by the cannula, though the anesthesia may have played a role. The possibility of embolism as a cause of death is believed to have been fairly well ruled out by postmortem studies on both lungs and skull. Unfortunately necropsy was not performed. The most probable explanation of the fatality is considered to be a sudden reaction to the iodized oil. It is felt that the patient may have been sensitized by the earlier injection to such an extent that the second amount proved fatal when it entered the blood stream.

SYDNEY J. THOMAS, M.D.

THE GENITO-URINARY SYSTEM

Nephrolithiasis in Skeletal Affections. A. Schüpbach. Schweiz. med. Wchnschr. **77:** 76–79, Jan. 11, 1947.

The author points out that there are two types of urinary lithiasis: that due to infection and that due to hyperexcretion of calcium salts. This latter type may occur whenever very active calcification of bone is taking place, as in severe multiple fractures, especially those resulting from war wounds. The relationship between von Recklinghausen's disease, hyperparathyroidism, and nephrolithiasis is well known. Albright's dictum that renal symptoms may occur in the absence of skeletal changes is emphasized. Other diseases, such as bone or joint tuberculosis, multiple myeloma, or hypercalcemia may result in a similar hyperexcretion of calcium in the urine. Five cases are reported, two of von Recklinghausen's disease and one each of visceral sarcoidosis with generalized skeletal foci, of extreme primary osteomalacia, and of symptomatic sprue resulting from gastric resection. All of the patients showed kidney stones due to hyperexcretion of calcium.

LEWIS G. JACOBS, M.D.

Certain Urographic Figures: Precapillary Shadows (*Images en boule*) and the Kidney Shadow. R. Hickel. J. de radiol. et d'électrol. **27:** 509–515, 1946.

The principal emphasis of this paper is upon watching pyelograms for a visualization of the caliceal tip in the absence of the usual visibility of the infundibulum. The mechanism of this phenomenon is gone into in some detail and the hydrostatics of the situation are made clear. The resultant clinical fact is that varying degrees of obstruction below the kidney pelvis produce a visualization *en boule*. Back pressure of urine dammed above a ureteral stone or kink or other obstruction prevents free urinary secretion; hence, the dye is held back, and only the caliceal tips are brought into relief. In the presence of such shadows on one side, or both, the logical route of inquiry is in the direction of discovering a ureteral obstruction, even though no evidence of such has been hitherto apparent.

When there is no back pressure in the kidney pelvis, the outline of the kidney parenchyma is not likely to be so sharp, since urine escapes freely from the kidney, fills the infundibula without hindrance, and the *images en boule* are no longer sharply evident for lack of contrast.

PERCY J. DELANO, M.D.

Spinal Cord Injuries: Urethrographic Studies of the Bladder Neck. George C. Prather and Boris Petroff. J. Urol. **57:** 274–284, February 1947.

Material for this paper was accumulated at two Army hospitals in the United States that were designated as centers for men with spinal cord injuries. The object was to record the anatomical status of the bladder neck in such patients. Observations were made in 129 cases.

Two methods of urethrography were employed. The urethrograms reproduced in the paper were obtained following retrograde injection from the external meatus with 25 to 30 c.c. of opaque medium and represent a resting urethra.

In 36 of the cases there was complete transection of the spinal cord or cauda equina, and in 30 of these there was some dilatation of the bladder neck. Among the 93 patients with partial transection there were 65 with some dilatation or relaxation of the bladder neck. None of the patients was seen within as short a time as four weeks following injury, and in most cases two to four months had elapsed. Even so, the time factor showed an appreciable effect on the observations, especially in cases of complete transection of the cord. Of 8 such patients examined within three months after injury, 3 showed normal urethrograms and 5 presented some evidence of dilatation. In a similar group of 28 men whose initial urethrographic examination was made four to twelve months after injury, only 3 had no dilatation of the bladder neck. In cases of partial transection the time element appeared less impressive.

The cases are further considered according to the level of the injury. There were no cases of complete transec-

tion of the cervical portion of the cord. Of the 10 patients with partial cervical transection, 6 showed dilatation. Complete thoracic transection occurred in 29 cases, and the ratio of dilated to normal bladder neck in this group was almost 4 to 1. With partial thoracic transection there was a much higher percentage of normal findings, 12 out of 29. All patients with complete cauda transection had dilatation of greater or lesser degree. Even in partial transections of the cauda the patients with dilatation numbered 3 1/2 times as many as those with normal findings.

It appears that dilatation of the bladder neck is predominant but not constant in those with complete transection of the spinal cord, and that the same finding is always present in complete transection of the cauda equina. In those with partial transection, dilatation of the bladder neck is common and occurs with increasing frequency from the level of the cervical region to the csuda equina. JOSEPH P. TOMSULA, M.D.

Venous Invasion Due to Urethrograms Made with Lipiodol. E. Granville Crabtree. J. Urol. **57:** 380–389, February 1947.

Although venous invasion has been reported in connection with pyelography, uterosalpingography, and less commonly with ureterography, there appears to be no mention in the American literature of invasion of the venous channels demonstrated roentgenographically following urethrography. Clinically venous invasion has been suggested by "catheter chills" indicating septicemia, and by sudden deaths from cocaine and other anesthetics used in the urethra.

A total of 27 cases of venous invasion from urethrography demonstrated by x-ray were collected from the European literature. Edling (Acta radiol. Supp. LVIII, 1945) found it 15 times in a series of 570 cystourethrograms. Among the 27 collected cases there were 4 deaths, due to emboli from oily media and thorium. Death from fat embolism may be instantaneous or delayed for a few days, and is dependent on the region in which the embolism occurs. In some instances no harm results; the oily medium, when it reaches the veins or lodges in the tissues, disappears slowly, in weeks to months. Thorium is especially contraindicated, as it is a tissue irritant and remains permanently.

An important consideration in determining the readiness with which the veins are entered from the lumen of the urethra is the great vascularity of the organ and the thinness of the lining. When the urethra is distended, the mucosa has a thickness of only 2 to 3 thin flat cells. A survey of the reported cases reveals that permeation of the veins can occur either from the use of undue force from without, during injection, or from force supplied by the bladder and abdominal muscles in voiding against obstruction in the urethra. The phenomenon is more likely to result when urethrography is done on patients with acute urethritis, after injury, and after instrumentation.

There does not appear to be any close relation between the amount of medium injected, discomfort produced during injection, or bleeding caused by the injection and the occurrence of venous invasion. In most of the cases in which the phenomenon occurred there was no discomfort and x-ray alone demonstrated the dye in the veins.

Apparently the veins may be patchily filled and incompletely outlined by the opaque medium, and as a result can easily be missed or misinterpreted when the phenomenon of invasion does occur.

A case of venous invasion following urethrography with roentgenographic illustrations is fully reported by the author. DAVID S. MALEN, M.D.

TECHNIC

X-Ray Exposure Meters and Automatic Exposure Timers. L. M. Garrett. Texas State J. Med. **42:** 597–602, February 1947.

This is a down-to-earth, simple interpretation of the highly complicated mechanism of the exposure meter and the automatic exposure timer which should be read by everyone not understanding their principles and uses. The exposure meter is an electronic device based on a photoelectric cell, which is used to ascertain the correct setting of the x-ray machine for making the actual roentgenogram. The automatic exposure timer, on the other hand, is incorporated in the x-ray equipment and cuts off the x-ray when the correct exposure is made. The electronic devices which are used to perform these tasks are explained in some detail, which is well within the comprehension even of one not skilled in electronics. SYDNEY F. THOMAS, M.D.

A Method of X-Ray Reproduction of the Negative X-Ray Film. Arthur Rest and Leona Stroud. Am. Rev. Tuberc. **55:** 184–186, February 1947.

A method of direct reproduction of the x-ray film is described. It utilizes the fluorescence of an intensifying screen activated by x-rays as the source of light. The film to be reproduced is placed in the cassette next to the top, or opening screen, of the cassette. An unexposed film then is placed next to the negative x-ray film, and between it and the back screen of the cassette is placed a sheet of black paper. The film is exposed using a 40-inch distance, 100 ma., 42 kv.p., and a time of one-half second. The resulting reproduction is a positive of the x-ray negative, but detail and contrast are equal to the original. L. W. PAUL, M.D.

RADIOTHERAPY

General Factors in Irradiation Therapy. Curtis F. Burnam. Ann. Otol., Rhin. & Laryng. **55:** 764–778, December 1946.

Irradiation of the Nasopharynx. Samuel J. Crowe. Ibid. **55:** 779–788, December 1946.

These two papers were presented in a Symposium on Irradiation Therapy in Otolaryngology and Ophthalmology. The first reviews certain facts concerning irradiation that are familiar to all radiologists and concludes with some general principles of the application of these agents in ophthalmology and otolaryngology. The second takes up the irradiation of the nasopharynx with the aid of a special radium applicator (see Burnam and Crowe: Mississippi Valley M. J. **67:** 109, 1945. Abst. in Radiology **47:** 208, 1946), for the destruction of excessive lymphoid tissue, which is so frequent a cause of deafness. Under this treatment the lymphoid tissue around the tubal orifices gradually disappears, marked

improvement or complete return of hearing follows, and in many cases the bluish discoloration of the tympanic membrane also disappears.

Oft-repeated attacks of eustachian tube obstruction are a common cause of impaired hearing in children. Repeated examinations, for research purposes, of 1,365 unselected public school children showed that adenoids recur in more than 75 per cent of those whose tonsils and adenoids have been removed before puberty. Nearly 40 per cent of these had either impaired hearing for high tones alone or for all tones in the speech range. In addition to loss of hearing, the regrowth of lymphoid tissue after operation predisposes to recurrent upper respiratory infections, attacks of suppurative otitis media, sinusitis, and bronchial infections. For several years the author has supplemented every tonsillectomy with irradiation of the nasopharynx. The first treatment is given about two weeks after the operation, and two additional treatments are given at intervals of two weeks. With the 50 mg. monel metal applicator, the dosage for all treatments is eight and a half minutes on each side.

Operative removal of very large adenoids, followed by a series of radium treatments, is always more satisfactory than irradiation alone, because of the mechanical difficulty of applying adequate irradiation to a large mass in this area with the nasopharyngeal applicator. It is decidedly dangerous to plunge the applicator into the mass of adenoids, to bend the applicator, or to construct it with a hinge so the angle of the radium-containing chamber may be changed. This introduces a hazard that the radium-containing part may some day break away and be swallowed or aspirated. If the adenoids are relatively small, however, and it is possible to introduce the applicator far enough into the nasopharynx to permit sufficient irradiation of the tubal orifices, the fossa of Rosenmüller and the lateral walls, then operation is not necessary.

The radium applicator should not be used in the nose itself for any condition except nodules of lymphoid tissue. Polyps are extremely resistant, and the applicator is not suitable for the treatment of malignant growths. It was designed for one purpose alone—the removal of lymphoid tissue.

During the war approximately 25,000 treatments were given with the monel metal radium applicator by medical officers of the Army Air Forces and at the New London Submarine Base, in order to prevent recurrent aerotitis and thus conserve manpower. The average result was 90 per cent effective. Not a single instance of radium burn or radium poisoning, with a drop in the white count, has been reported. The author has given treatments with the nasopharyngeal applicator almost daily for twenty years and has suffered no ill effects. The only requirements are an accurate examination with the nasopharyngoscope to establish the indication for radium treatment, placing the applicator so that the side, not the end, of the radium-containing chamber is in contact with the tissue to be treated, and finally the greatest care to time each treatment accurately.

Precautions for the protection of office personnel are included. It is of the utmost importance for the radium to be stored and the treatments to be given at least 20 feet from those who are daily exposed to its effects. The two-inch lead cylinder that comes with the applicator is intended to make transportation practicable, but for storage in an office the lead should be at least 6 inches in thickness.

STEPHEN N. TAGER, M.D.

Mechanism of Radiation Effects against Malignant Tumors. Shields Warren. J. A. M. A. **133:** 462–463, Feb. 15, 1947.

The author presents a brief discussion of radiation effects on malignant tumors. One of the important ways of influencing growth, both normal and abnormal, is by radiation. It is the radiant energy absorbed by the tissue or cell that is effective, not that which is delivered to it. All types of ionizing radiations—the roentgen ray, the gamma ray, the alpha particle, the beta particle, the neutron—have essentially the same qualitative effects on cells exposed to them, so far as can be determined by histologic examination.

The first noticeable effect on cells is interference with mitosis, which is closely followed by vacuolization and swelling of the cytoplasm. Later pyknosis and autolysis of the injured cells take place. Partial or complete recovery of some of the tumor cells occurs, and were it not for secondary effects on the connective-tissue stroma and blood vessels, no lasting effects on an irradiated part would be noted. Fibrous tissue and hyaline act as barriers to metabolic exchange of tumor cells and hinder their spread.

The law of Bergonié and Tribondeau, according to which the radiosensitivity of cells is in inverse ratio to their degree of differentiation, while holding true to some degree, has many exceptions. Tumors which regress with a dose of irradiation that does little harm to adjacent tissues, up to 2,500 r, may be called radiosensitive. Radioresponsive tumors are considered as those which regress with dosage of 2,500–5,000 r, with adjacent tissue harmed to a moderate degree. Radioresistant tumors are those which do not respond any better than adjacent normal tissue. Radiosensitive tumors are not necessarily radiocurable.

Radioactive isotopes, particularly of phosphorus and iodine, which are absorbed selectively to some degree, make possible irradiation of tumor cells without too much injury to normal cells. JOSEPH HANELIN, M.D.
(University of Michigan)

Limits of Roentgen Therapy of Cancer. A. Rosselet. Schweiz. med. Wchnschr. **77:** 106–107, Jan. 11, 1947.

A very general discussion, containing nothing new, of reasons for the lack of material improvement in the results of radiation treatment of cancer in the last few years. Special emphasis is placed on radiosensitivity and "our ignorance of methods which would permit us to change cellular radiosensitivity, to increase its amount; in other words, to transform a radioresistant cell into a radiosensitive cell more vulnerable to the actions of radiations. And we do not see in other sciences, as chemistry or biochemistry, capabilities of giving us a solution to this problem—if there is one!"

LEWIS G. JACOBS, M.D.

Cancer of the Eyelid Treated by Radiation; with Consideration of Irradiation Cataract. Howard B. Hunt. Am. J. Roentgenol. **57:** 160–180, February 1947.

From a critical study of 100 selected cases of cancer of the eyelid the author forms the opinion that the treatment of choice is fractionated roentgen therapy. The eyeball and lens can be effectively protected against superficial roentgen rays and beta rays by an eyeshield equivalent to 1 mm. of lead. No eyeshield is adequate for protection against the more penetrating gamma rays of radium. In a fifteen-year period of observation 4 of

the 100 patients died from cancer of the eyelid. Therapeutic failures result from (*a*) advanced and inaccessible disease; (*b*) impairment of the tumor bed by prior inadequate therapy; (*c*) insufficient or uneven doses; (*d*) incomplete marginal coverage of lesion, and (*e*) inadequate follow-up of patients.

Histopathology: Biopsy was done in 70 of the 100 cases. Basal-cell carcinoma constituted 70 per cent of the neoplasms, squamous-cell 15 per cent, mixed squamous-cell and basal-cell, or keratinizing basal-cell lesions 5 per cent, with the more benign lesions such as keratotic horns and papillomas making up the remaining 10 per cent. Biopsy is occasionally foregone to minimize scarring.

Distribution, Extension, and Metastases: Forty-eight per cent of the lesions occurred along the lower lid and 34 per cent above the inner canthus, with only 6 per cent along the upper lid and 12 per cent adjacent to the outer canthus. Extension is primarily by direct infiltration with occasional extensive subcutaneous progression of basal-cell lesions or local permeation along adjacent lymphatics with the production of what appear to be multiple foci. Lymphatic penetration of the orbital fascia may give rise to intra-orbital metastases with pain and proptosis. Lesions about the inner canthus tend to invade the lacrimal duct, with occasional ulcerative invasion into the ethmoid sinuses. Squamous-cell lesions may metastasize to the regional nodes. The superficial and deep lymphatics from the lateral three-fourths of the upper lid and the lateral aspect of the lower lid drain laterally into the superficial and deep parotid nodes just in front of and below the ear. The medial group of lymphatics drain the region of the inner canthus and the medial three-fourths of the lower lid, and follow the course of the facial vein down into the submaxillary group of nodes.

Effect of Irradiation on the Eye: Conjunctivitis precedes epidermitis of the skin by three to five days. The eyelashes are lost from the irradiated area after ten to twenty days and have not returned in areas successfully treated for cancer of the eyelid. The crystalline lens is very susceptible to irradiation injury, although a period of three months to twelve years may elapse before cataract becomes apparent. It now seems well established that the primary mechanism of irradiation cataract is direct injury to the subcapsular epithelial cells along the anterior aspect of the equator of the lens. Eighty-eight per cent of gamma radiation from radium passes through 2 mm. of lead and 83 per cent through 3 mm. of lead. A 1-mm. lead shield will absorb 99+ per cent of x-radiation energized by 80 kv. without filter, and 97+ per cent of radiation energized by 140 kv. filtered through 0.25 mm. of copper and 1 mm. aluminum, according to the author's measurements.

Radiotherapy: Roentgen therapy has become the radiotherapeutic method of choice due to its proved effectiveness, accuracy, simplicity, and restriction of exposure more closely to the diseased area. The larger the lesion in extent, the more advisable fractionation becomes, in order to preserve the health and nutrition of the tumor bed. Fractionation is also advantageous in lesions over 3 or 4 mm. in thickness, since shrinkage of the tumor following initial exposures permits more effective exposure of the base of the cancer, with relatively less irradiation of underlying tissues. Inasmuch as roentgen dosage on small lesions is usually recorded in air without back-scattering, it is essential to bear in mind that air dosage must be increased about 10 to 50 per cent when dealing with lesions less than 10 to 5 mm. in size in order to deliver dosage comparable to that developed in a lesion 20 to 30 mm. in size.

With a single roentgen treatment, an average dosage of 2,875 r in air was found effective. An average dosage of 3,400 to 4,200 r in air was employed when two treatments were delivered within a period of two to seven days. A total dosage of 4,500 to 5,400 r in air was employed when three treatments were delivered within a period of three to fourteen days. A total dosage of 5,000 to 8,500 roentgens was employed if five or more equal treatments were delivered during a period of five to twenty-one days. In general, this method proved effective in eradication of cancer of the eyelid with maximal preservation of the uninvolved tissues and with minimal injury to the eye when it was properly protected by an eyeshield.

ELLWOOD W. GODFREY, M.D.

Radiotherapy of Epitheliomas of the Eyelids. F. Baclesse, M. Dollfus, A. Ennuyer, and J. Reverdy. J. de radiol. et d'électrol. **27:** 515–526, 1946.

This article contains a comprehensive description of malignant lesions of the eyelid, classifies them histologically, and gives end-results of treatment. In general, the authors use lead shields (external) and retract the affected portion as much as possible. Sometimes, when using very high-intensity radiation, where the time will be short, they rely somewhat upon the patient, who is instructed to keep his eye rotated to a fixed point, thus tilting it out of border radiations.

Most of the ocular complications observed by the authors have followed the use of radium plaques; they have had the least trouble with the Chaoul type of instrument. The article includes a complete discussion of the complications of treatment by the attending ophthalmologist, who takes up the injuries (which have been slight and infrequent) in order and discusses their prevention.

This is a most worth-while article and is recommended to all who have found treatment of eyelid lesions beset with difficulties. PERCY J. DELANO, M.D.

Cancer of the Tongue. George S. Sharp and Harold D. Spickerman. Am. J. Roentgenol. **57:** 181–198, February 1947.

The authors analyze 81 unselected consecutive proved cases of cancer of the tongue. Twenty-seven patients were seen in private practice and 54 at the Veterans Administration Facility, Los Angeles. It is felt that leukoplakia concomitant with lingual carcinoma favored successful treatment, as the growth is usually slow and of a low degree of malignancy, while the tendency to invade adjacent tissues or to metastasize to cervical nodes is less pronounced. On the other hand, a highly inflamed growth associated with ulceration is locally agressive and metastases are the rule. Still another course is characterized by moderate local growth and early massive metastases to the cervical nodes.

A classification is proposed which indicates the condition of the primary lesion and the presence and extent of secondary involvement. Stage I consists of a primary growth less than 1.5 cm. in diameter. Nine cases fitted into this category with 5 or 55.5 per cent five-year cures. Stage II comprises 14 cases with the primary growth less than 3 cm. diameter, and 7 or 50.0 per cent five-year

cures. In Stage III the primary growth is of indeterminate size with unilateral operable cervical nodes. Thirty cases were so classified, with 7 or 23.3 per cent five-year cures. In Stage IV the primary growth invades surrounding structures with inoperable cervical metastases. Twenty-eight cases belonged in this group with 1 or 3.6 per cent five-year cures. One of the most important factors in every respect—diagnosis, therapy, and prognosis—is the presence or absence of metastatic involvement of cervical lymph nodes.

In the treatment of the primary lesion, surgery has been replaced by irradiation. Whenever possible, intracavity treatment cones are used perorally, while external fields of irradiation are employed only as a supplement or when the site of the lesion cannot be reached by a peroral cone. Whether the radiation is administered exclusively through the oral cavity, or whether supplementary external fields are used, a daily dose of 400 r in air is considered desirable, the total dosage being 4,000 to 4,800 r, depending on the size of the cone. This is delivered with 200 kv., 15 ma., and with a Thoraeus filter equivalent to 2.0 mm. of copper. Target-to-skin distance is 25 cm. for the intra-oral cone and 50 cm. for external irradiation. Radium needles are implanted on the last day of roentgen therapy for an average exposure of 1,200 mg.-hr. in the anterior two-thirds of the tongue and 800 mg.-hr. at the base. The 1,200 mg.-hr. amount to 4,800 gamma roentgens for a lesion 2.5 cm. in diameter and a volume of about 8 c.c.; this would be equivalent to approximately 4.8 erythema doses. If it is assumed that the tissue exposure at the base of the lesion corresponds to 75 per cent of the roentgen exposure in air, it would average about 3,600 "tissue roentgens" or roughly 5.2 erythema doses. Adding these two *biological* values of exposure, the total is found to be in the neighborhood of 10 erythema doses. With interstitial needles rather than radon seeds, radiation necrosis is less frequent, the result is less painful, and it has not been found necessary to remove the growth, as has been unavoidable in the case of radon seeds.

Palliative treatment also begins with roentgen therapy. By peroral administration, a total dose of 4,000 r in air usually proves sufficient to remove radiating as well as local pain. An external portal is used exclusively in those cases where it is possible to aim the radiation through cervical nodes into the primary growth. Immediately afterward, interstitial irradiation by means of radium needles is instituted. A cancerous growth involving one-half of the tongue will require 1,500 to 1,600 mg.-hr. while in more extensive lesions 2,000 mg.-hr. may be needed. These doses will permit a possible repetition of interstitial irradiation, while roentgen therapy may also be repeated after an interval of three months.

Radical neck dissection should in no case be undertaken earlier than two or three weeks after the treatment of the primary lesion has been terminated. If by that time it is evident that the lingual growth has been responding satisfactorily to radiation therapy, neck surgery can be undertaken provided all of the following conditions are fulfilled: (1) the general condition of the patient warrants; (2) the life expectancy is weighed against the statistical surgical risk; (3) cervical nodes are considered as operable only if the primary lesion has not transcended the midline and has, on the basis of primary growth biopsy, proved to be of only limited malignancy; (4) the secondary metastatic involvement has remained unilateral; (5) the node—or nodes—is movable and shows little evidence of invasion. An irregular outline of a metastatic node, or its partial fixation, indicates that the involvement has extended beyond the capsule, and in such cases dissection would lead to contamination of the operative field and to subsequent recurrence.

Where radical block dissection is not feasible, interstitial irradiation supplements more extensive roentgen therapy. ELLWOOD W. GODFREY, M.D.

Carcinoma of the Breast. Karl F. Kesmodel. South. M. J. **40:** 43–46, January 1947.

An analysis of the cases treated by the author for a five-year period between 1936 and 1941 is presented. It is again emphasized that the survival rate is greatly reduced when the axillary nodes are already involved by the carcinoma when the patient comes to surgery. Radiation is stressed as an important therapeutic agent in the relief of pain from bone metastases. The value of castration as an adjunct in therapy remains questionable. The author refers to the work of Adair and Herrmann (Ann. Surg. **123:** 1023, 1946), who used testosterone propionate in the treatment of 11 patients, 4 of whom exhibited a favorable response. None was used in the present series.

The author's routine method of prophylactic postoperative x-ray therapy is described. If for any reason surgical treatment cannot be undertaken in a patient who is considered "surgically curable," roentgen therapy is instituted.

Radiation sickness, the most frequent complication to therapy, is treated by a combination of thiamin hydrochloride and pyridoxine hydrochloride, 50 mg. of each per c.c. of solution. One cubic centimeter, intravenously or intramuscularly, on alternate days is usually sufficient.

The author urges the consideration, treatment, and care of the so-called "incurable" cancer patients in view of the fact that their lives can be prolonged and their pain can be relieved. MORRIS IVKER, M.D.

Lymphosarcoma of the Bladder, with Brief Review of the Literature. Benjamin Levant and Richard E. Rosenfield. Urol. & Cutan. Rev. **51:** 6–9, January 1947.

Primary lymphosarcoma of the bladder is a rare neoplasm. It was first reported in American literature in 1942 by Kreutzmann (J. Urol. **48:** 147, 1942). There have been seven cases in all reported in the literature since 1885, exclusive of the one here recorded, and pertinent details of these are tabulated. The symptomatology of this disease is similar to that of any other tumor of the bladder: pain, hematuria, and urinary retention. The diagnosis is made by means of cystoscopy, cystograms, and microscopic studies. The best results have been obtained by resection followed by irradiation.

The author reports a case of primary lymphosarcoma of the bladder which appears to be of the reticulum-cell type. Treatment was by resection followed by radiation therapy, and at the time of the report, less than a year after operation, the patient was without evidence of recurrence. MAURICE D. SACHS, M.D.

Radiotherapeutic and Radiosurgical Indications in Cancer of the Rectum. R. Mathey-Cornat. J. de radiol. et d'électrol. **27:** 533–536, 1946.

This article on cancer of the rectum, rather than presenting any new departure in treatment or even a de-

tailed consideration of treatment technic, is intended mostly as a summary. The author states at the outset that 50 per cent of the cases he dealt with were inoperable when first seen.

Tables are compiled showing the extent of involvement and the recovery rate in the favorable cases: the best group seems to be the one treated by operation, followed by radiotherapy. No cases are tabulated in which surgery alone was employed; though this group should be of interest.

The author believes firmly in preoperative irradiation. The protagonists of this school of thought are diminishing in this country, probably faster than they are in France, where the idea of radiation has a more tenacious hold, possibly as a long shadow cast by the Curie Institute. When the radiologist has the upper hand in a clinic, preoperative irradiation is apt to be the rule; if the surgeon has the authority, preoperative irradiation is invariably conspicuous by its absence. Actually, if radiation has any place in the treatment of carcinoma of the rectum, it is as a palliative measure, either with or without operation; it seems to retard somewhat the more painful and otherwise distressing features of the terminal stages and serves a psychologic value in giving the patient's relatives something on which to pin their flagging hopes.

PERCY J. DELANO, M.D.

Carcinoma of the Anus. Orville N. Meland. Am. J. Roentgenol. **57:** 199–202, February 1947.

Meland previously reported (Am. J. Roentgenol. **43:** 706, 1940) on a series of 13 patients with squamous-cell carcinoma of the anus treated by irradiation alone. He now presents a follow-up on these patients along with information on 12 additional patients. He concludes that this form of therapy gives a reasonable hope for complete recovery with added hope of sphincter control. While some patients have some atresia of the anus, this is not enough to seriously inconvenience them. Even with this disability they are better off than the patients with a colostomy. It is felt that external irradiation, when successful in destroying the disease, usually results in less sphincter disability than interstitial irradiation. Metastases in the uncontrolled cases involved the retroperitoneal nodes, liver and brain, rather than the groin.

ELLWOOD W. GODFREY, M.D.

Primary Malignant Tumours of Bone. Symposium. Stanford Cade, R. W. Scarff, F. Campbell Golding, and S. Bryan Adams. Brit J. Radiol. **20:** 10–30, January 1947.

Cade points out that most malignant bone tumors fall into five classes: osteogenic sarcoma, Ewing's tumor, multiple myeloma, parosteal sarcoma, and osteoclastoma (giant-cell tumor). The clinical differences in the various types are well presented in a table which permits easy comparison.

A history of trauma is frequent. Pain and tumor are the chief clinical features, pain always preceding swelling. The balance between osteogenesis and osteoporosis in any tumor depends in part on the type of tumor and also on differences in vascularity. "Sun-ray" spicules and "onion-peel" layer are not always diagnostic of sarcoma.

Metastasis occurs with all malignant bone tumors, most commonly to the lungs and the lymphatic system, the viscera and the skeletal system. Bone metastases are particularly frequent in Ewing's tumor.

Ewing's sarcoma is the most sensitive to radiation and parosteal sarcoma the least. Irradiation will cause regression in sensitive types but it is not permanent. The best results are obtained with a combination of irradiation and surgery.

Preoperative irradiation should always be given for osteogenic sarcoma. Even when this fails to arrest the tumor growth, it temporarily inhibits the activity of the tumor, though there is no evidence that the delay alters the patient's chances of survival. In some cases regression may be so great that amputation may be postponed.

Multiple myeloma does not lend itself to surgical treatment.

Parosteal sarcomas call for amputation, followed by irradiation of the stump.

Good results are obtained in osteoclastoma by both surgery and irradiation. Surgery should be resorted to in young children, in moderate sized tumors where the bone destruction is small, in tumors of the digits, and in cases in which the tumor has extended to the neighboring joint. Irradiation is indicated in healthy adults, for inaccessible tumors, and for large growths. The effects of radiation become apparent in six weeks and continue for eight to ten months. A combination of surgery and irradiation is usually not advisable.

Scarff discusses certain pathological and radiological aspects of bone tumors. The relation of trauma to etiology is still unsettled, though there is considerable evidence that trauma plays a part in causing sarcoma and angio-endothelioma.

The histologic appearance is important in the diagnosis. No real evidence has yet been brought forward to show that biopsy increases the liability to metastasis.

An exhaustive classification of bone tumors is not possible with our present state of knowledge. The following broad classification is suggested: infiltrating chondroma, osteogenic sarcoma, extraperiosteal fibrosarcoma, medullary fibrosarcoma, myeloma, Ewing's tumor, angio-endothelioma, and chordoma.

Since there is no correlation between the histologic appearance of *osteogenic sarcoma* and the prognosis, there is little point in dividing this group into subdivisions. *Medullary fibrosarcoma* should be recognized as distinct from periosteal sarcoma because the prognosis is better. *Infiltrating chondroma* starts as an apparently benign growth, but frequently develops the character of a highly malignant osteogenic sarcoma. There is considerable confusion in the *Ewing's tumor* group. Many are really neuroblastomas. *Angio-endothelioma* shows a great variety of histological structure. Differentiation from secondary hypernephroma and Ewing's tumor may be impossible.

Golding discusses the relationship of the radiologist and the pathologist to diagnosis. He feels that greater accuracy in diagnosis will result from more attention to histology and thorough correlation of the pathologic and x-ray findings. Radiologic diagnosis alone is not accurate enough. This is particularly true in giant-cell tumors, central osteolytic tumors, and chondrosarcomas.

Adams discusses the sensitivity of osteogenic sarcoma to radiation, pointing out that there is great variation in response, and great difficulty in evaluating results. Since the disease is so uniformly fatal, every method of treatment should be tried.

SYDNEY J. HAWLEY, M.D.

Radiation Therapy for the Removal of Adenoid Tissue. Donald F. Proctor. Arch. Otolaryng. **45:** 40–48, January 1947.

This is a further report of experiences at the Hagerstown (Maryland) Clinic for the treatment of deafness in children (Arch. Otolaryng. **43:** 473, 1946. Abst. in Radiology **48:** 317, 1947). During the past three years, a total of 1,110 radium treatments have been given, using the Monel metal applicator designed by Crowe and Burnam, for the elimination of adenoids in 400 patients. Seventy-six patients received only a single radium treatment; 1 patient had nine treatments, and 1 has had ten treatments. The average period of observation for the total of 400 was thirteen months at the time of the report, and most of the interesting cases had been followed for almost two years. These patients received, in addition to radiation therapy, surgical treatment of the tonsils or adenoids when indicated (mastoidectomy or nasal operation in some instances), and local treatments to the sinuses, the nose, or the ears. The treatment in many cases is not yet completed and the results should not be considered final. They are taken up under two headings (1) changes in the nasopharyngeal lymphoid tissue, (2) changes in symptoms. At the last examination, 99 patients had no lymphoid tissue in the nasopharynx, and in an additional 167 patients only minute traces remained. At the first examination, 127 patients had a large mass of adenoid tissue, and 7 patients still had a large mass when last seen. At the first examination, 29 patients had normal eustachian orifices, and at the last examination 255 had normal eustachian orifices. Seventy-one surgical removals of lymphoid tissue were carried out on the 400 patients during the period of observation.

Audiometer tests were performed two or more times on 542 ears during this period. On the first test, 119 ears were normal, in 280 hearing was slightly impaired, in 111 moderately impaired, and in 32 severely impaired. At the last test, the hearing of 234 ears remained unchanged (101 of these normal on the first test), the hearing of 284 had improved, and in only 24 had the hearing grown worse. Twelve of 33 chronically discharging ears healed completely during the period of observation, 9 became dry though perforations persisted, and 12 continued to discharge. Of 178 patients subject to unusually frequent and severe acute infections of the upper respiratory tract, 113 stopped catching colds completely or had few, mild colds. Of 19 patients with bronchial asthma, 9 no longer had attacks, and 5 others were greatly improved.

X-ray Irradiation to Promote Ovulation. John O. Haman. West J. Surg. **55:** 107–111, February 1947.

The author advocates treatment of amenorrhea with small doses of x-rays over the ovaries and over the pituitary. The dosage to the pelvis varied from 225 r to 300 r, with a similar dose over the pituitary. Treatments were given once weekly. Of the 32 patients treated, ovulation was restored in 23. However, careful scrutiny of the article reveals that some of these patients received thyroid extract and others estrogens. In one patient out of the series a permanent amenorrhea developed. Of 18 presumably sterile women, 66 per cent became pregnant.

[Results of the above treatment would seem encouraging but they are open to question on two scores. (1) The small number of cases reviewed. In some of these women there might have been a return of menstruation without treatment. (2) Since both the pituitary gland and the ovaries were treated by radiation, it is not possible to tell which gland was the more responsible for the resumption of ovulation. Until more definite proof of the stimulating effect of radiation can be obtained at the hands of several observers, these treatments should not be generally recommended.—R. C. P.] ROBERT C. PENDERGRASS, M.D.

Functional Uterine Bleeding. M. Edward Davis. M. Clin. North America **31:** 223–235, January 1947.

Abnormal uterine bleeding is the most frequent gynecologic complaint. The term functional is applied to this bleeding when no organic disease of the reproductive organs is found. The bleeding is not in the normal pattern, and it can consist of an increased flow or a prolongation of the bleeding period (menorrhagia) or a complete irregularity of the menstrual pattern (metrorrhagia). The author takes up the causes and treatment of functional bleeding during adolescence, during the childbearing period, and at the menopause. It is with the patients in the last group that the radiologist is particularly concerned.

The treatment of bleeding at the climacteric involves several important principles. The possibility of cancer must be ruled out by careful examination—visualization of the cervix and biopsy of any questionable lesion, and a diagnostic curettage in the absence of gross disease. If cancer has been ruled out, the onset of the amenorrhea of a natural menopause can be awaited unless the bleeding is considerable and troublesome. If, however, the bleeding should be stopped, some procedure leading to an artificial menopause should be adopted. Endocrine therapy must never be used for the control of functional bleeding at this time. Benign bleeding of the menopause can be treated by removal of the uterus, by either an abdominal or vaginal hysterectomy, if there are no contraindications to surgery. In younger women this method is preferred to irradiation, since ovarian function can be saved. Many clinicians feel, however, that in the menopausal period the ovaries have outlived their usefulness and remain as potential sites of neoplasms, particularly carcinoma, and that they should therefore be removed.

Irradiation controls functional bleeding in the menopausal period by destroying the remaining ovarian function. It is as effective as surgery in patients with normal pelvic organs, provided there is a proper selection of cases. The contraindications to irradiation in this selected group of cases are: (1) Uncertainty as to extent of the pathologic involvement. Whenever it is impossible to determine the exact state of the pelvic organs, surgery is preferable to radiation. (2) Inflammatory conditions of the reproductive tract, particularly the adnexa, contraindicate irradiation. (3) Previous pelvic surgery. (4) Radiophobia. X-ray, radium and cancer are so closely associated in the minds of many patients that the use of radiation for the control of bleeding may be followed by undesirable mental reactions. Such patients are best treated by surgery.

If deep roentgen therapy is used, the amount of irradiation which has been found effective in a large group of patients should be given. In most cases 400 r to each ovary will produce a permanent cessation of function.

The author's method for applying radium for castra-

tion is illustrated. Two capsules are inserted in tandem; the upper one in the uterine cavity contains radium and the lower one in the cervical canal extending through the internal os is empty. The total amount of irradiation necessary to produce castration consistently is about 1,800 to 2,000 milligram hours. The duration of the application depends upon the amount of radium used. However, in most instances no more than 50 to 100 mg. of radium are necessary.

Radium and Roentgen Therapy in the Treatment of Menopausal Uterine Bleeding. Herbert E. Schmitz and Janet E. Towne. Am. J. Obst. & Gynec. **53:** 199–204, February 1947.

The authors record the irradiation of a series of 412 women varying in age from forty to fifty-one years who manifested abnormal uterine bleeding. The bleeding in no case was due to a malignant growth, as revealed by diagnostic curettage, which was performed in all cases prior to the institution of therapy. It should be noted, however, that 236 patients had small myomas, which in no case were larger than a three months' gestation.

Most of the cases were treated with intrafundal application of radium. In order to secure complete amenorrhea, 1,800 mg. element hours were necessary. A 2-mm. brass capsule containing 50 mg. of radium was inserted in the uterine cavity for thirty-five hours. The remainder of the patients were successfully treated with external irradiation, employing a tissue dosage of approximately 500 r delivered into the mid pelvis through two fields, one suprapubic and one sacral (200 kv., filtration of 0.5 to 1.0 mm. Cu plus 1.0 mm. of Al). It is concluded that in selected cases of benign uterine hemorrhage, irradiation should be employed rather than major surgery. FRANCIS F. HART, M.D.

Evaluation of the Surgical Treatment of Recurrent Echinococcic Cysts of the Liver Followed by Deep X-Ray Therapy. G. M. Dorrance and J. S. Bransfield. Am. J. Trop. Med. **27:** 77, January 1947.

In 1928, a patient was operated upon for echinococcic cyst of the liver. A recurrence, five years later, involved about one-sixth of the liver substance. After removing a large number of daughter cysts and necrotic material, the cyst was marsupialized by sewing the cut edges to the peritoneum. Six months after the operation, daughter cysts were being extruded from the sinus. Over a twenty-day period, ten x-ray treatments, totaling 1,200 r, were given over the anterior surface of the liver (200 kv., with a filter of 0.5 mm. Cu and 1 mm. Al), followed by nine treatments over the posterior surface for a total of 1,030 r. Two weeks following the second treatment, no cysts were extruded from the sinus, and a week later it had healed. Nine years later there was no evidence of recurrence.

Benign Giant Cell Tumor of Bone: Report of a Case Treated by X-Ray Radiation 5 Years ago. Paterno S. Chikiamco. J. Philippine M. A. **23:** 19–22, January 1947.

A case of giant-cell tumor involving the upper portion of the humerus and a part of the epiphyseal head was diagnosed roentgenologically in January 1940. The tumor responded promptly to deep x-ray therapy (dosage not given), and a roentgenogram of the affected area in December 1945 shows the bone practically normal.

RADIOACTIVE ISOTOPES

Radioactive Phosphorus (P^{32}) and Alkylamines (Nitrogen Mustards) in the Treatment of Neoplastic and Allied Diseases of the Hemopoietic System. Leon O. Jacobson, Charles L. Spurr, T. R. Smith, and G. F. Dick. M. Clin. North America **31:** 3–18, January 1947.

Radiophosphorus and methyl bis (β-chloroethyl) amine hydrochloride (called Dema for the sake of brevity), like x-radiation, have definite limitations in the treatment of neoplastic diseases of the hemopoietic system. The course of the acute leukemias and multiple myeloma is unaffected by these agents. Radiophosphorus usually does not favorably influence the course of Hodgkin's disease, while Dema and roentgen therapy produce definite remissions. More or less comparable remissions are produced in chronic myelogenous leukemia by the administration of P^{32} and x-radiation, while Dema produces only a short or wholly unsatisfactory clinical response. The three agents are roughly equivalent in therapeutic efficacy in lymphosarcoma. Radiophosphorus induces satisfactory remissions in polycythemia rubra vera with regularity: observations on patients after treatment with Dema are not long nor extensive enough to permit a logical comparison with the results obtained with P^{32}. Dema has produced clinically significant remissions in the few patients thus far.

Radiophosphorus is effective in the diseases discussed when given orally or intravenously. If given by mouth, it should be administered in orange juice in the morning and breakfast omitted or postponed for at least two to three hours. A 75 per cent absorption should be assumed with oral administration. The effective and "safe" dose or dosage schedule is highly individualized. The possible serious toxic reactions to the isotope are leukopenia, thrombocytopenia, and anemia.

The dose of Dema in the diseases in which a trial is indicated is usually 0.1 mg. per kilogram of body weight per day intravenously for four consecutive days. In individual cases a shorter or longer course of therapy may be indicated. The serious toxic manifestations of Dema which may ensue are (1) nausea and vomiting two to three hours after administration of the drug, (2) thrombophlebitis and thrombosis at the site of injection if the material is not sufficiently dilute when given intravenously, and (3) leukopenia, thrombocytopenia and anemia.

Four case histories are presented to illustrate the therapeutic effect and some toxic manifestations of P^{32} and Dema. References to the literature are included.

Preliminary Report on the Use of Radioactive Phosphorus in Australia. A. G. S. Cooper. M. J. Australia **1:** 104–113, Jan. 25, 1947.

This paper covers the results of the treatment of 18 patients with radioactive phosphorus. There were 5 cases of lymphosarcoma, 4 of chronic myeloid leukemia, 4 of chronic lymphatic leukemia, 2 of giant follicular lymphadenopathy, and 1 each of Hodgkin's disease, acute lymphatic leukemia and polycythemia vera.

The drug was given intravenously in all cases, using a rapid fractional saturation method in most instances. Of the lymphosarcoma patients, 2 are living in good condition, three years and six months, respectively, after

treatment; one lived in good condition for fourteen months, but died at twenty months; 2 died three months and eleven months, respectively, after treatment, the last having been inadequately treated. Of the patients with chronic myeloid leukemia, 2 are living one year or more and 2 have died at four months and a year, respectively. Of those with chronic lymphatic leukemia, 2 are living eight and ten months, respectively, after treatment; 1 died of myocarditis shortly after treatment began and the other died in three months. The last was in the terminal phase when treatment was started.

One of the patients with giant follicular lymphadenopathy died at five months, having received treatment for palliation only; the other is living for thirteen months with moderate improvement. In the case of Hodgkin's disease, only a tracer dose was given. The patient with acute lymphatic leukemia received dramatic relief from dyspnea produced by massive mediastinal node enlargement, but died in six weeks. The case of polycythemia vera showed marked improvement over a period of three months and the patient was living at the time of this report.

The dosage varied from 2,000 to 7,000 microcuries per series of injections. The spacing of injections varied somewhat according to the disease present. In many instances, radioactive phosphorus therapy was supplemented by deep x-ray therapy. The author concludes that some cases showed good response even when apparently resistant to deep roentgen therapy. The remissions in chronic leukemia were generally longer than those obtained by deep x-ray therapy.

BERNARD S. KALAYJIAN, M.D.

Effects of Radioactive Phosphorus (P^{32}) on Normal Tissues: A Histologic Study of the Changes Induced in the Organs of Patients with Malignant Lymphomas. William R. Platt. Arch. Path. **43:** 1–14, January 1947.

Although much has been written about the distribution and deposition of P^{32} in the peripheral blood and body tissues of certain laboratory animals and individual patients, few reports have been made on the histologic changes induced by this type of beta particle radiation.

The author reports a microscopic study of tissues from 43 cases, including leukemias, Hodgkin's disease, multiple myeloma, lymphosarcoma, melanoma, and Ewing's sarcoma. Patients with malignant lymphomas who had not been treated with any type of radiation were studied as controls. Grossly, the observable changes were minimal. The following changes, it was felt, could be attributed to the effects of P^{32}.

Brain: Of 11 cases examined, a few showed retrogressive changes such as disappearance of Nissl granules, loss of nuclei, pyknosis of chromatin matter, swelling, and chromatolysis. Some changes were occasionally noted in the small blood vessels and capillaries.

Skin: The epidermis and dermis showed pathological changes quite similar to those following direct irradiation. These ranged from extreme atrophy, disarrangement and disappearance of the basement membrane of epidermal cells, to marked hyperkeratosis. None of the extreme telangiectatic changes associated with local application of roentgen rays could be demonstrated.

Esophagus: The stratified squamous epithelium covering the mucous membrane of the esophagus revealed the same type of response that was seen in other epithelium-lined internal structures; that is, vacuolation and desquamation of the epithelial cells with edema of the submucosa and infiltrating abnormal blood cells.

Gastro-Intestinal Tract: The mucosal epithelial lining showed occasional foci of superficial ulceration. Overproduction of mucus by goblet cells, which were enlarged and increased in number, was occasionally seen in distorted glands. Multinucleated, atypical giant cells were seen between the acini and in the submucosal coat proper. The muscle fibers were the sites of hyaline degeneration, interstitial fibrosis, edema, vacuolation, and atrophy.

Liver: Liver changes which could be attributed directly to P^{32} were minimal when compared with the more frequently observed alterations in hepatic cells resulting from the anoxia of the severe associated anemia and with the degenerative changes secondary to the leukemic cellular infiltration.

Bone Marrow: Myeloid hyperplasia was shown in 20 cases; lymphoid hyperplasia and infiltration with hypoplasia of the other formed elements in 2; hypoplasia of all the blood cells in 2; and diffuse necrosis and fibrosis of the medullary cavities of both flat and long bones in 18.

Lymph Nodes: There was complete destruction of pattern in practically all of the leukemic nodes examined. This was usually associated with infiltration of immature myeloid, monocytic, and lymphoid cells.

Spleen: None of the spleens studied was smaller than normal. The external capsular surface was usually thickened and grayish-white. Microscopically there was masking of the normal pattern by the malignant cellular invasion. Occasional extramedullary hemopoietic foci were also seen. The alterations more closely related to P^{32} therapy are an increase in fibrous tissue involving the trabeculae and the sinusoidal and arteriolar walls, focal fibrinous necrosis and hyalinization of these structures, and an increase in the number of multinucleated giant cells.

Kidneys, Ureters, and Bladder: Because of the difficulty of distinguishing renal changes secondary to primary vascular disease and those due to beta radiation, only those 15 cases in which the patient was below forty years of age were considered. The most characteristic changes were thickening and fibrosis of the renal capsule and hyalinization and thickening of Bowman's capsule, with only rare involvement of the basement membrane of the glomerular tuft. Also observed were hyperemia, swelling, vacuolation, and desquamation of the epithelium of the tubules, especially the convoluted tubules. In the bladder there were varying degrees of hyperemia, occasional edema, desquamation of epithelial cells, and increase in hyalinized connective tissue, involving the mucosa, submucosa, and muscularis.

Endocrine System: In the *pituitary gland* there was a slight to moderate increase of connective tissue distributed between the acini. The greatest and most constant alteration in the *adrenals* was marked dissolution of cells and loss of cellular detail. There were no significant changes in the *thyroid* or *parathyroid*. In the *pancreas* there was moderate to marked interacinic and interlobular fibrosis, with occasional hyaline changes in the collagen fibers.

Reproductive Organs: In 11 of 16 patients under forty, there were varying degrees of destruction of the germinal epithelium of the testes. In practically all

instances the seminiferous tubules showed thickening and varying degrees of hyalinization of the tunica propria and the basement membrane. The most conspicuous change in the *ovaries* was disappearance of the primary and graafian follicles.

Heart: Minimal degenerative changes were observed in the myocardium and coronary blood vessels in 14 of 21 patients under forty years of age.

Lungs: Pulmonary alterations ranged from moderate congestion, edema, lymphangiectasis, slight inflammatory cell infiltration and minimal degenerative metaplastic changes in bronchial and alveolar epithelium to well defined hyaline membrane formation, extreme thickening of alveolar walls, focal atelectasis, and thickening of pulmonary vessels, with associated swelling of collagen and hyalin degenerative changes therein.

Bone: In the bone there were disappearance of osteoblasts and absence of osteocytes and lacunas.

Skeletal Muscle: Loss of cross striations, fragmentation of fibers, homogeneity of myoplasm, and nuclear karyorrhexis were characteristic changes in skeletal muscle.

Those tissues which utilize phosphorus rapidly and which also have a high phosphorus content, *i.e.*, bone marrow, liver, spleen, and lymph nodes, specifically take up higher concentrations of radioactive phosphorus than do normal tissues. Therefore, proportionately higher concentrations of radioactivity are formed in those tissues preferentially involved in malignant lymphomas and primary polycythemia. Also, it is noted that in almost every therapeutic application of radiation, normal tissues are affected as well as the intentionally radiated focus of disease. The effect on the bone marrow has led to variable hematologic complications. When two or more of the cellular elements of the marrow were depressed in the same patient, the formed elements of the peripheral blood showed changes in the following order: The leukocyte level decreased first, the thrombocyte level second, and the erythrocyte level last. The most prominent alterations in immature marrow cells were in the megakaryocytes, which were degenerated or absent in most of the marrow sections studied. Therefore, on the basis of clinical and pathological studies, reaction to P^{32} in order of decreasing cellular sensitivity should be leukocytes and leukopoietic tissue, megakaryocytic tissue, and lastly erythropoietic tissue.

The urinary excretion of P^{32} varies from 5 to 25 per cent during the first four to six days in patients with leukemia and polycythemia vera, but 25 to 50 per cent is excreted by normal subjects in the same period. The difference is attributed to quick fixation of P^{32} in pathologic tissues and cells. The resultant prolonged irradiation of the renal parenchyma could result in nephritis and hypertension.

Serious consideration should be given to the changes in the testes and ovaries of patients in the reproductive period of life. PAUL W. ROMAN, M.D.

EXPERIMENTAL STUDIES

Pituitary-Adrenal Cortical Control of Lymphocyte Structure and Function as Revealed by Experimental X-Radiation. Thomas F. Dougherty and Abraham White. Endocrinology **39:** 370–385, December 1946.

CBA mice, 60 to 80 days old, were given total body x-radiation. A large dose, 200 r, produced within three hours a lymphopenia, tissue lymphocyte degeneration, and total serum protein and gamma globulin increases. These changes also occurred in adrenalectomized mice receiving 200 r one day after operation. This dose gave an anamnestic response (*i.e.*, enhancement of antibody titer) in previously immunized mice in the absence of the adrenals.

It was demonstrated that 10 r produced the same physiological alterations, including the anamnestic response, in normal, but not in adrenalectomized, mice. Therefore, 10 r influenced lymphoid tissue function by augmenting pituitary-adrenal cortical secretion. Large doses of x-radiation may produce lymphocyte degeneration without adrenal mediation and thus increase circulating gamma globulin and antibodies. This is further proof that adrenal cortical steroids produce hyperglobulinemia by their degenerative effects on the lymphocyte, an end cell of adrenal cortical hormone action.

It is suggested that x-rays exert both a direct and an indirect effect on lymphocytes. The direct action may be manifested even in the absence of pituitary or adrenals, whereas the indirect action is mediated *via* the pituitary-adrenal cortical mechanism.

The Conjugate Role of Trauma and of a Radioactive "Soil" in the Production of Experimental Osteosarcoma. G. Gricouroff and H. Fajerman. Atomes et radiations **1:** 32–37, November–December 1946.

The authors have carried out carefully controlled experimental work in which a number of laboratory animals were given intensive radiation, sometimes by radium implantation and sometimes by intravenous injections of radioactive salts, and were then, under anesthesia, made the subjects of fractures of various bones. The healing fractures were followed with films for varying periods, and the dates at which identifiable sarcomas of bone appeared at the fracture sites were recorded. Some tumors were seen as early as five months after the fracture; others a year or more later. In most of the cases, metastases were widespread. In some instances, where no sarcoma developed, the fracture callus was huge, out of all proportion to that ordinarily found in simple fracture.

One cannot but conclude, after surveying these experiments, that any amount of radioactive material introduced into the body must carry with it a certain hazard. PERCY J. DELANO, M.D.

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